SOLID STRUCTURE

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention is concerned with a solid structure that can be used as an office, a working place, a temporary house, a lodging house, a store, a warehouse, a factory, or as a structure of which the upper part can be used as internal space (e.g., office, domicile, working place) and the lower part can be used as external space such as garage, and for many other purposes.

Description of the Related Art

There has heretofore been proposed a solid structure (for example, a solid parking lot) by arranging assembly elements for corners, assembly elements for sides and assembly elements for centers, which are the poles, at required positions, coupling beams across the upper ends of these assembly elements, and coupling braces among the lower ends thereof (see Japanese Examined Patent Publication (Kokoku) No. 06-015786 and U.S. Patent No. 4800694). This solid structure has excellent characteristics in that it can be assembled and disassembled within relatively short periods of time at relatively low costs without at all requiring buried foundation structures yet featuring a sufficient degree of strength and rigidity as a solid structure.

In the above solid structure, however, the assembly elements for corners, assembly elements for sides and assembly elements for centers are still relatively heavy, requiring relatively laborious assembling operation. Therefore, the above solid structure has been improved over its preceding structures in regard to the assembling period and total cost, which, however, is not still satisfactory enough. Besides,

in addition to relatively heavy assembly elements, the structures of the individual elements are not simple arousing problems such as large space is required for storage, cost of storage becomes high, transportation to the site of assembly involves difficulty and increased cost. Besides, though the solid structure can be favorably used as a solid parking lot or as a solid bicycle parking lot, its use is still relatively narrow leaving room for improvement in this respect, too.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a novel solid structure which makes it possible to easily and quickly carry out the assembling operation on the site of assembly, to shorten the period for assembling, and to decrease the total cost.

Another object of the present invention is to provide a novel solid structure which makes it possible to easily and quickly carry out the disassembling operation on the site of assembly, and to shorten the period for disassembling and removal.

A further object of the present invention is to provide a novel solid structure of which the individual constituent elements and the whole constitution are relatively light in weight and are simple yet maintaining a sufficiently large strength.

A still further object of the present invention is to provide a novel solid structure of which the entire constituent elements can be assembled by using bolts and internally threaded members.

A yet further object of the present invention is to provide a novel solid structure which requires a reduced space for storage and a decreased cost for storage.

A further object of the present invention is to provide

a novel solid structure which can be easily transported to the site of assembly decreasing the cost of transportation.

Another object of the present invention is to provide a novel solid structure which can be used for a variety of purposes, such as an office, a working place, a temporary house, a lodging house, a store, a warehouse, a factory and the like.

According to one aspect of the invention, there is provided a solid structure provided with a frame having struts arranged in a rectangular shape as viewed on a plane and beams extending horizontally and coupling the struts, said frame forming a solid space of substantially a rectangular parallelopiped shape, wherein:

corner struts arranged at the corners of the frame have a polygonal shape in cross section, ends of side beams constituted by H-beams having a web, an upper flange and a lower flange are coupled to the inner side walls of the corner struts, the inner side walls meeting at right angles to each other and facing in the horizontal direction along the side edges of the frame meeting at right angles to each other;

a plurality of pairs of first internally threaded members are buried between the inner side wall which is one of the inner side walls of the corner strut and the outer side wall positioned on the side opposite to the one inner side wall maintaining a distance in the up-and-down direction, the plurality of first internally threaded members extending in parallel at the same height maintaining a distance in the horizontal direction and forming internally threaded holes at one end thereof in a manner that the internally threaded holes are opened in the outer surface of the one inner side wall, and a pair of through holes are formed in each pair of the first internally threaded members maintaining a distance in the axial direction, meeting the axes horizontally at right angles, and extending in parallel with each other;

a plurality of pairs of second internally threaded members are buried between the other inner side wall which is one of the inner side walls of the corner strut and the other outer side wall positioned on the side opposite to the other inner side wall maintaining a distance in the up-and-down direction, the plurality of second internally threaded members having axes common to the pair of axes of the through holes formed in each pair of the first internally threaded members and forming internally threaded holes at one end thereof in a manner to penetrate through the through holes of the corresponding pair of the first internally threaded members and so as to be opened in the other inner side wall;

rectangular coupling plates are secured to the ends of the side beams at right angles with the side beams coupled to the corner strut, and a plurality of mounting holes are formed in the coupling plates on each side divided by the web maintaining a distance in the up-and-down direction;

the one side beam has the coupling plate that is substantially brought into contact with the one inner side wall of the corner strut in a manner that the mounting holes of the coupling plate are in alignment with the internally threaded holes of the pairs of the first internally threaded members opened in the one inner side wall of the corner strut, and is detachably fastened to the one inner side wall of the corner strut by bringing the bolts into engagement with the internally threaded holes through the mounting holes; and

the other side beam has the coupling plate that is substantially brought into contact with the other inner side wall of the corner strut in a manner that the mounting holes of the coupling plate are in alignment with the internally threaded holes of the pairs of the second internally threaded members opened in the other inner side wall of the corner strut, and is detachably fastened to the other inner side wall of the

corner strut by bringing the bolts into engagement with the internally threaded holes through the mounting holes.

According to another aspect of the invention, there is provided a solid structure provided with a frame having struts arranged in a rectangular shape as viewed on a plane and beams extending horizontally and coupling the struts, said frame forming a solid space of substantially a rectangular parallelopiped shape, wherein:

side struts arranged between the corner struts arranged at the corners of the frame have a polygonal shape in cross section, ends of side beams constituted by H-beams having a web, an upper flange and a lower flange are coupled to the side walls of the side struts, the side walls facing in a horizontal direction along the side edges of the frame;

a plurality of pairs of internally threaded members are buried between the side walls of the side struts maintaining a distance in the up-and-down direction, the plurality of internally threaded members extending in parallel at the same height maintaining a distance in the horizontal direction and having internally threaded holes at both ends thereof in a manner that the internally threaded holes are opened in the corresponding side walls;

rectangular coupling plates are secured to the ends of the side beams at right angles with the side beams, and a plurality of mounting holes are formed in the coupling plates on either side divided by the web maintaining a distance in the up-and-down direction;

the one side beam has the coupling plate that is substantially brought into contact with the one side wall of the side strut in a manner that the mounting holes of the coupling plate are in alignment with the internally threaded holes opened in the one side wall of the side strut, and is detachably fastened to the one side wall of the side strut by

bringing the bolts into engagement with the internally threaded holes of the internally threaded members through the mounting holes; and

the other side beam has the coupling plate that is substantially brought into contact with the other side wall of the side strut in a manner that the mounting holes of the coupling plate are in alignment with the internally threaded holes opened in the other side wall of the side strut, and is detachably fastened to the other side wall of the side strut by bringing the bolts into engagement with the internally threaded holes of the internally threaded members through the mounting holes.

It is desired that the upper surfaces of the side beams are positioned substantially at the same height.

It is desired that the side beams have substantially the same shape and the same size in cross section.

According to a further aspect of the invention, there is provided a solid structure provided with a frame having struts arranged in a rectangular shape as viewed on a plane and beams extending horizontally and coupling the struts, said frame forming a solid space of substantially a rectangular parallelopiped shape, wherein:

side struts arranged between the corner struts arranged at the corners of the frame have a polygonal shape in cross section, ends of one inner side beam and of two side beams constituted by H-beams having a web, an upper flange and a lower flange are coupled to the inner side walls of the side struts facing the inside of the solid space of the frame and to the side walls thereof facing in the horizontal direction along the side edges of the frame;

a plurality of pairs of first internally threaded members are buried between the side walls of the side struts maintaining a distance in the up-and-down direction, the plurality of first

internally threaded members extending in parallel at the same height maintaining a distance in the horizontal direction and having internally threaded holes at both end thereof in a manner that the internally threaded holes are opened in the side walls, and a pair of through holes are formed in each pair of the first internally threaded members maintaining a distance in the axial direction, meeting the axes horizontally at right angles, and extending in parallel with each other;

a plurality of pairs of second internally threaded members are buried between the inner side wall of the side strut and the outer side wall positioned on the side opposite to the inner side wall having axes common to the pair of axes of the through holes formed in each pair of the first internally threaded members and forming internally threaded holes at one end thereof in a manner to penetrate through the corresponding pair of through holes of the first internally threaded members and so as to be opened in the inner side wall;

rectangular coupling plates are secured to the ends of the inner side beam and of the side beams at right angles with the inner side beam and with the side beams coupled to the side strut, and a plurality of mounting holes are formed in the coupling plates on each side divided by the web maintaining a distance in the up-and-down direction;

the one side beam has the coupling plate that is substantially brought into contact with the one side wall of the side strut in a manner that the mounting holes of the coupling plate are in alignment with the internally threaded holes opened in one side wall of the side strut, and is detachably fastened to the one side wall of the side strut by bringing the bolts into engagement with the internally threaded holes on one side of the pairs of the first internally threaded members through the mounting holes;

the other side beam has the coupling plate that is

substantially brought into contact with the other side wall of the side strut in a manner that the mounting holes of the coupling plate are in alignment with the internally threaded holes opened in the other side wall of the side strut, and is detachably fastened to the other side wall of the side strut by bringing the bolts into engagement with the other internally threaded holes of the pairs of the first internally threaded members through the mounting holes; and

the inner side beam has the coupling plate that is substantially brought into contact with the inner side wall of the side strut in a manner that the mounting holes of the coupling plate are in alignment with the internally threaded holes opened in the inner side wall of the side strut, and is detachably fastened to the inner side wall of the side strut by bringing the bolts into engagement with the internally threaded holes of the pairs of the second internally threaded members through the mounting holes.

It is desired that the upper surfaces of the inner side beam and of the side beams are positioned substantially at the same height.

It is desired that the inner side beam and the side beams have substantially the same shape and the same size in cross section.

It is desired that the corner struts and the side struts are constituted by metallic pipes having a square shape in cross section, and the internally threaded members are made of a metal and are inserted and secured by welding in the through holes formed in the corner struts and in the side struts.

According to a still further aspect of the invention, there is provided a solid structure provided with a frame having struts arranged in a rectangular shape as viewed on a plane and beams extending horizontally and coupling the struts, said frame forming a solid space of substantially a rectangular

parallelopiped shape, wherein:

at least the upper ends of the corner struts arranged at the corners of the frame are constituted by polygonal metallic pipes, ends of the upper side beam made of a metallic pipe having a square shape in cross section are coupled to the inner side walls at the upper end of the corner strut meeting at right angles with each other, the inner side surfaces facing in the horizontal direction along the side edges meeting at right angles of the frame;

a pair of mounting holes are formed at the upper ends of the one inner side wall and of the other inner side wall of the corner strut at the same height maintaining a distance in the horizontal direction;

rectangular coupling plates are secured to the ends of the upper side beams at right angles with the upper side beams coupled to the corner strut, and a pair of internally threaded holes are formed in the coupling plates maintaining a distance in the horizontal direction;

the one upper side beam has the coupling plate that is substantially brought into contact with the one inner side wall of the corner strut in a manner that the internally threaded holes of the coupling plates are in alignment with the mounting holes in one side wall of the corner strut, and is detachably fastened to the one inner side wall of the corner strut by bringing the bolts into engagement with the internally threaded holes from the upper open end of the corner strut through the mounting holes; and

the other upper side beam has the coupling plate that is substantially brought into contact with the other inner side wall of the corner strut in a manner that the internally threaded holes of the coupling plates are in alignment with the mounting holes in the other side wall of the corner strut, and is detachably fastened to the other inner side wall of the

corner strut by bringing the bolts into engagement with the internally threaded holes from the upper open end of the corner strut through the mounting holes.

It is desired that the upper surfaces of the corner strut and of the upper side beams are positioned substantially at the same height.

It is desired that the upper side beams have substantially the same shape and the same size in cross section.

According to a yet further aspect of the invention, there is provided a solid structure provided with a frame having struts arranged in a rectangular shape as viewed on a plane and beams extending horizontally and coupling the struts, said frame forming a solid space of substantially a rectangular parallelopiped shape, wherein:

at least the upper ends of the side struts arranged between the corner struts arranged at the corners of the frame are made of metallic pipes having a polygonal shape in cross section, an end of an upper side beam constituted by an H-beam having a web, an upper flange and a lower flange is coupled to the inner side wall at the upper end of the side strut, the side wall facing the inside of the solid space of the frame, and the ends of the upper side beam made of a metallic pipe having a square shape in cross section are coupled to the side walls at the upper end of the side strut, the side walls facing in the horizontal direction along the side edges of the frames;

a plurality of pairs of internally threaded members are buried between the inner side wall of the side strut and the outer side wall positioned on the side opposite to the inner side wall at the same height in parallel maintaining a distance in the horizontal direction, the plurality of internally threaded members having the internally threaded holes that are opened in the inner side wall;

a pair of mounting holes are formed at the same height

maintaining a distance in the horizontal direction at the upper ends of the side walls of the side strut at positions higher than the internal threaded members;

rectangular coupling plates are secured to the ends of the upper inner side beams at right angles with the upper inner side beams which are coupled to the upper ends of the inner side walls of the side struts, and a plurality of mounting holes are formed in the coupling plates on either side divided by the web maintaining a distance in the up-and-down direction;

rectangular coupling plates are secured to the ends of the upper side beams at right angles with the upper side beams which are coupled to the side walls at the upper ends of the side struts, and a pair of internally threaded holes are formed in the coupling plate at the same height maintaining a distance in the up-and-down direction;

the upper inner side beam has the coupling plate that is substantially brought into contact with the inner side wall of the side strut in a manner that the mounting holes of the coupling plate are in alignment with the internally threaded holes opened in the inner side wall of the side strut, and is detachably fastened to the inner side wall of the side strut by bringing the bolts into engagement with the internally threaded holes of the pairs of the internally threaded members through the mounting holes;

the one upper side beam has the coupling plate that is substantially brought into contact with the one side wall of the side strut in a manner that the internally threaded holes of the coupling plate are in alignment with the mounting holes in one side wall of the side strut, and is detachably fastened to the one side wall of the side strut by bringing the bolts into engagement with the internally threaded holes through the mounting holes; and

the other upper side beam has the coupling plate that

is substantially brought into contact with the other side wall of the side strut in a manner that the internally threaded holes of the coupling plate are in alignment with the mounting holes in the other side wall of the side strut, and is detachably fastened to the other side wall of the side strut by bringing the bolts into engagement with the internally threaded holes through the mounting holes.

It is desired that the upper surfaces of the upper side beams and of the upper inner side beam are positioned substantially at the same height.

It is desired that the upper side beams have substantially the same shape and the same size in cross section.

According to a still further aspect of the invention, there is provided a solid structure provided with a frame having struts arranged in a rectangular shape as viewed on a plane and beams extending horizontally and coupling the struts, said frame forming a solid space of substantially a rectangular parallelopiped shape, wherein:

one or a plurality of rectangular side edge spaces are formed in each of a plurality of side edge regions formed in the frame, the one or the plurality of spaces being surrounded by a pair of side beams facing each other in the up-and-down direction and by a pair of struts facing each other in a horizontal direction, and one or a plurality of rectangular side wall units are fitted to all side edge spaces or to at least all side edge spaces excluding the one in the frame;

hollow mounting members are integrally arranged at the corners of the side wall unit and at the side edges, the hollow mounting members having a square shape in cross section and being constituted by four side walls having a predetermined thickness and a width in the axial direction, and the hollow mounting members being so arranged that the axes thereof are directed to both surfaces of the side wall unit;

mounting holes are formed in the two side walls facing outward of the side wall unit, the two side walls meeting at right angles with each other in the hollow mounting members arranged at the corners of the side wall unit, and mounting holes are formed in one side wall facing outward of the side wall unit in the hollow mounting members arranged at the side edges of the side wall unit;

internally threaded members forming threaded holes at an end thereof are arranged in the pair of side beams and in the pair of struts defining the side edge space at positions corresponding to the mounting holes of the hollow mounting members in one or a plurality of side wall units fitted to the side edge space, the hollow mounting members facing the pair of side beams and the pair of struts in a manner that the internally threaded holes are opened in the side edge space, wherein when the side wall unit is fitted into the side edge space, the mounting holes of the hollow mounting members are brought into alignment with the internally threaded holes of the corresponding internally threaded members, and in this state, the side wall unit is detachably fastened to the pair of side beams and to the pair of struts by bringing the bolts into engagement with the internally threaded holes of the corresponding internally threaded members through the mounting holes.

It is desired that the two side walls meeting at right angles of the hollow mounting member arranged at a corner of the side wall unit or the two side walls facing outward of the side wall unit, define a portion of the side walls of the side wall unit meeting at right angles at the corner of the side wall unit; and one side wall of the hollow mounting member arranged along the side edge of the side wall unit or the one side wall facing outward of the side wall unit, defines a portion of the side wall along the side edge of the side wall

unit.

It is desired that the side wall unit includes two side frames extending at right angles along the two side edges from the hollow mounting member arranged at a corner, and brace frames extending aslant relative to the two side frames; and a substantially right-angled triangle is formed by two side frames and by the brace frames as viewing the side wall unit on a plane.

It is desired that the hollow mounting members are formed by cutting a square metallic pipe which is a common part.

It is desired that the hollow mounting members are integrally made of cast iron that can be welded, braces are provided at four corners of each hollow mounting member spanning across the two side walls that are meeting at right angles with each other, the brace has a predetermined thickness and a width in the axial direction same as that of the two side walls, and the brace forms a right-angled triangle relative to the two side walls as viewing the hollow mounting members in the axial direction.

It is desired that the upper side beam and the pair of struts defining the side edge space are constituted by metallic pips having a square shape in cross section, and the internally threaded members are made of a metal and are inserted in the through holes formed in the upper side beam and in the pair of struts and are secured therein by welding.

It is desired that the lower side beam defining the side edge space is constituted by an H-beam having a web, an upper flange and a lower flange; mounting holes are formed in the lower side beam at positions corresponding to the mounting holes of the hollow mounting members of the side wall unit, the mounting holes being in concentric with the axis that passes through the center of the web in the direction of width and meets the upper and lower flanges at right angles, and the

mounting holes extending from the upper surface of the upper flange up to the upper end of the web; and the internally threaded members are inserted in the corresponding mounting holes in a manner that the internally threaded holes are opened in the upper surface of the upper flange and are secured therein by welding.

It is desired that a plurality of side wall units are fitted into the side edge space so as to be neighboring each other; in the side wall units neighboring each other, the side walls of the hollow mounting members constituting a portion of side walls facing each other are so positioned as to be opposed to each other in a manner that the mounting holes thereof are aligned to each other; and the side wall units neighboring each other are detachably fastened together by inserting the bolts in the aligned mounting holes of the hollow mounting members that are opposed to each other and engaging nuts therewith.

According to a further aspect of the invention, there is provided a solid structure provided with a frame having struts arranged in a rectangular shape as viewed on a plane and beams extending horizontally and coupling the struts, said frame forming a solid space of substantially a rectangular parallelopiped shape, wherein:

the frame has a plurality of rectangular floor spaces surrounded by four beams, a rectangular floor unit is mounted on each floor space, the peripheral edges of the floor unit are constituted by frame members having a vertical wall and a flange extending outward from the upper end of the vertical wall at right angles, and each floor unit is fitted to the floor space from the upper side, the peripheral flanges are placed on the upper surfaces of the four beams defining the floor space, and the vertical walls are detachably fastened to the corresponding beams by using bolts and internally threaded

members.

It is desired that the four beams defining the floor spaces are constituted by H-beams having a web, an upper flange and a lower flange; the support plates are secured by welding between the opposing ends of the upper flange and the lower flange at portions where the floor units are coupled to the four beams; internally threaded members forming internally threaded holes at one end thereof are secured by welding between the support plates and the side surface of the web in a manner that the internally threaded holes are opened in the outer surface of the support plates; mounting holes are formed in the vertical walls of the floor units so as to be corresponded to the internally threaded holes of the internally threaded members; and the floor units are detachably fastened to the four beams defining the corresponding floor spaces by bringing the bolts into engagement with the internally threaded holes of the internally threaded members through the mounting holes in a state where the floor units are fitted into the corresponding floor spaces from the upper side.

According to another aspect of the invention, there is provided a solid structure provided with a frame having struts arranged in a rectangular shape as viewed on a plane and beams extending horizontally and coupling the struts, said frame forming a solid space of substantially a rectangular parallelopiped shape, wherein:

the frame includes upper side beams that couple the upper ends of the struts facing each other and define rectangular peripheral edges together with the struts as viewed on a plane, and a rectangular upper space surrounded by the struts and by the upper side beams;

a plurality of rectangular roof units are mounted on the upper ends of the frame so as to cover the upper space from the upper side;

end-engaging flange means are arranged on the lower surfaces at both ends in the lengthwise direction of the roof units hanging down from the lower surfaces;

the roof units are mounted at their both ends on at least one upper side beam defining a pair of side edges that are facing each other of the frame; and

the end-engaging flange means are positioned being overlapped on the inner sides and/or on the outer sides of the corresponding upper side beams and are detachably fastened by bolts and internally threaded members, so that the roof units neighboring each other cover the upper space from the upper side.

It is desired that each end-engaging flange means comprises an end-engaging flange hanging down from the lower surfaces at both ends in the lengthwise direction of the roof unit or comprises a pair of end-engaging flanges hanging down from the lower surfaces at both ends in the lengthwise direction of the roof unit and are extending in parallel in the direction of width maintaining a distance in the lengthwise direction.

It is desired that one side-engaging flange means is hanging down from the lower surface on one side in the direction of width of the roof unit of the one side and is extending in the lengthwise direction, the roof unit of the one side being positioned on one side in a direction which is in agreement with the direction of width of the roof units in the upper space; the roof unit of the one side is positioned with its one side-engaging flange means being overlapped on the inner side and/or the outer side of at least one upper side beam that defines the one side edge of the another pair of side edges facing each other of the frame and is detachably fastened by bolts and internally threaded members; the other side-engaging flange means is hanging down from the lower surface on the other side of the roof unit of the other side in the direction of

width and is extending in the lengthwise direction, the roof unit of the other side being positioned on other side in a direction which is in agreement with the direction of width of the roof units in the upper space; and the roof unit of the other side is positioned with its other side-engaging flange means being overlapped on the inner side and/or the outer side of at least one upper side beam that defines the other side edge of the another pair of side edges facing each other of the frame and is detachably fastened by bolts and internally threaded members.

It is desired that the one side-engaging flange means comprises a one side-engaging flange hanging down from the lower surface on one side of the roof unit in the direction of width or a pair of one side-engaging flanges hanging down from the lower surface thereof on one side in the direction of width and are extending in parallel in the lengthwise direction maintaining a distance in the direction of width; and the other side-engaging flange means comprises an other side-engaging flange hanging down from the lower surface on the other side of the roof unit in the direction of width or a pair of other side-engaging flanges hanging down from the lower surface thereof on the other side in the direction of width and are extending in parallel in the lengthwise direction maintaining a distance in the direction of width.

It is desired that a ceiling panel member is arranged on the lower surfaces of the roof units and at least on the inner region of the end-engaging flange means, or on the lower surface of the roof unit of the one side and on at least the inner regions of the end-engaging flange means and of the one side-engaging flange means, or on the lower surface of the roof unit of the other side and on at least the inner regions of the end-engaging flange means and of the other side-engaging flange means.

It is desired that the roof unit comprises:

channel plates that are arranged in a rectangular shape to define the peripheral edges and having open ends that are directed inward, the channel plates having a vertical wall and an upper flange and a lower flange that are folded at right angles toward the insides from the upper end and the lower end of the vertical wall;

transverse beams arranged between the vertical walls of the channel plates facing each other in the direction of width of the roof unit maintaining a distance in the lengthwise direction of the roof unit in a manner that the height thereof gradually increases from a position close to one end of the roof unit up to a position close to the other end in the lengthwise direction;

a trough member arranged at one end in the lengthwise direction of the roof unit, stretching between the vertical walls of the channel plates facing each other in the direction of width of the roof unit, and having a drain port formed in the bottom thereof; and

at least one roof plate mounted on the transverse beams so as to extend from the other end up to the one end in the lengthwise direction of the roof unit in a manner of being inclined downward, the end of the roof plate having the smallest height in the lengthwise direction being positioned on the trough member.

It is desired that the roof unit comprises:

channel plates that are arranged in a rectangular shape to define the peripheral edges and having open ends that are directed inward, the channel plates having a vertical wall and an upper flange and a lower flange that are folded at right angles toward the insides from the upper end and the lower end of the vertical wall;

transverse beams arranged between the vertical walls of

the channel plates facing each other in the direction of width of the roof unit maintaining a distance in the lengthwise direction of the roof unit in a manner that the height thereof gradually increases from a position close to one end and from a position close to the other end of the roof unit in the lengthwise direction up to a central position of the roof unit in the lengthwise direction;

trough members arranged at one end and at the other end in the lengthwise direction of the roof unit, stretching between the vertical walls of the channel plates facing each other in the direction of width of the roof unit, and having drain ports formed in the bottoms thereof; and

at least one roof plate of the one side mounted on the transverse beams so as to extend from the center to the one end of the roof unit in the lengthwise direction in a manner of being inclined downward, and at least one roof plate of the other side mounted on the transverse beams so as to extend from the center to the other end of the roof unit in the lengthwise direction in a manner of being inclined downward, the lower end of the roof plate of the one side having the smallest height in the lengthwise direction and the lower end of the other roof plate having the smallest height in the lengthwise direction being positioned on the corresponding trough members.

It is desired that the one side edge in the direction of width of the roof unit of the one side is positioned midway in the direction of width of at least one upper side beam defining the one side edge of the other pair of side edges facing each other of the frame, and midway in the direction of width of the struts positioned on the extensions of the upper side beams, the roof unit of the one side being positioned on the one side in the direction in agreement with the direction of width of the roof units in the upper space; the other side of the trough unit of the one side of a rectangular shape on a

plane having a drain port in the bottom is detachably attached to the one side of the roof unit of the one side in the direction of width; and the trough unit of the one side includes a channel plate arranged in a rectangular shape having a length nearly equal to the roof unit of the one side in the lengthwise direction and having an open end facing inward, the channel plate being constituted by a vertical wall, and an upper flange and a lower flange folded inward at right angles from the upper end and the lower end of the vertical wall, and a trough member that extends between the vertical walls of the channel plate facing in the lengthwise direction of the trough unit of the one side and having a drain port in the bottom thereof.

It is desired that the height of the channel plate defining the other side in the direction of width of the trough unit of the one side is selected to be substantially the same as the height of the channel plate defining the one side in the direction of width of the roof unit of the one side; a mounting member having a mounting piece is secured to the channel plate defining the other side in the direction of width of the trough unit of the one side, the mounting piece hanging down from the lower surface of the channel plate; the trough unit of the one side has the outer surface of the vertical wall of the channel plate defining the other side in the direction of width of the trough unit of the one side that is overlapped on the outer surface of the vertical wall of the channel plate defining the one side in the direction of width of the roof unit of the one side, and is detachably fastened by using bolts and nuts; the bottom surface of the channel plate defining the other side in the direction of width of the trough unit of the one side is placed on the upper surfaces of the upper side beams and of the struts; and the mounting piece is overlapped on the outer side walls of the upper side beams and of the struts, and is detachable fastened to the upper side beams by using

bolts and internally threaded members.

It is desired that the other side edge in the direction of width of the roof unit of the other side is positioned midway in the direction of width of at least one upper side beam defining the other side edge of the other pair of side edges facing each other of the frame, and midway in the direction of width of the struts positioned on the extensions of the upper side beams, the roof unit of the other side being positioned on the other side in the direction in agreement with the direction of width of the roof units in the upper space; the one side of the trough unit of the other side of a rectangular shape on a plane having a drain port in the bottom is detachably attached to the other side of the roof unit of the other side in the direction of width; and the trough unit of the other side includes a channel plate arranged in a rectangular shape having a length nearly equal to the roof unit of the other side in the lengthwise direction and having an open end facing inward, the channel plate being constituted by a vertical wall, and an upper flange and a lower flange folded inward at right angles from the upper end and the lower end of the vertical wall, and a trough member that extends between the vertical walls of the channel plate facing in the lengthwise direction of the trough unit of the other side and having a drain port in the bottom thereof.

It is desired that the height of the channel plate defining the one side in the direction of width of the trough unit of the other side is selected to be substantially the same as the height of the channel plate defining the other side in the direction of width of the trough unit of the other side; a mounting member having a mounting piece is secured to the channel plate defining the one side in the direction of width of the trough unit of the other side, the mounting piece hanging down from the lower surface of the channel plate; the trough

unit of the other side has the outer surface of the vertical wall of the channel plate defining the one side in the direction of width of the trough unit of the other side that is overlapped on the outer surface of the vertical wall of the channel plate defining the other side in the direction of width of the roof unit of the other side, and is detachably fastened by using bolts and nuts; the bottom surface of the channel plate defining the one side in the direction of width of the trough unit of the other side is placed on the upper surfaces of the upper side beams and of the struts; and the mounting piece is overlapped on the outer side walls of the upper side beams and of the struts, and is detachably fastened to the upper side beams by using bolts and internally threaded members.

It is desired that internally threaded members extending in a horizontal direction and forming internally threaded holes at the one end and/or the other end thereof, are buried in the portions of the upper side beams defining the pair of side edges facing each other of the frame coupled to the roof units, in a manner that the internally threaded holes are opened in the inner side walls and/or the outer side walls of the corresponding upper side beams facing the upper space; mounting holes are formed in an end-engaging flange or in one or both of a pair of the end-engaging flanges arranged at both ends of the roof units in the lengthwise direction so as to be corresponded to the internally threaded members; and the one end-engaging flange or the pair of end-engaging flanges of the roof units are detachably fastened to the inner side walls and/or the outer side walls of the corresponding upper side beams by bringing the bolts into engagement with the threaded holes of the corresponding internally threaded members through the mounting piece.

It is desired that internally threaded members extending in a horizontal direction and forming internally threaded

holes at the one end and/or the other end thereof, are buried in the portions of the upper side beams defining the other pair of side edges facing each other of the frame coupled to the roof unit of the one side or to the roof unit of the other side, in a manner that the internally threaded holes are opened in the inner side walls and/or the outer side walls of the corresponding upper side beams facing the upper space; mounting holes are formed in a one side-engaging flange or in one or both of a pair of the one side-engaging flanges arranged on one side of the roof unit of the one side and in an other side-engaging flange or in one or both of a pair of the other side-engaging flanges arranged on the other side of the roof unit of the other side so as to be corresponded to the internally threaded members; and the one side-engaging flange or one or both of the pair of the one side-engaging flanges and the other side-engaging flange or one or both of the pair of the other side-engaging flanges are detachably fastened to the inner side walls and/or the outer side walls of the corresponding upper side beams by bringing the bolts into engagement with the threaded holes of the corresponding internally threaded members through the mounting piece.

It is desired that internally threaded members extending in a horizontal direction and forming internally threaded holes at the one end thereof, are buried in the portions of the upper side beams coupled to the trough unit of the one side and to the trough unit of the other side, in a manner that the internally threaded holes are opened in the outer side walls of the corresponding upper side beams; mounting holes are formed in the mounting pieces of the channel plates defining the other side in the direction of width of the trough unit of the one side and defining the one side in the direction of width of the trough unit of the other side; and the mounting pieces are secured to the outer side walls of the upper side

beams by bringing the bolts into engagement with the threaded holes of the corresponding internally threaded members through the mounting pieces.

It is desired that the upper side beams are constituted by metallic pipes having a square shape in cross section, and the internally threaded members are made of a metal and are inserted in the through holes formed in the upper side beams and are secured therein by welding.

It is desired that a seal plate member is detachably mounted on the upper end between the vertical walls of the channel plates facing each other of the roof units neighboring each other, the seal plate member being made of a metal having elasticity and including a flat plate-like sealing substrate having a predetermined width, both end flanges extending from both ends of the sealing substrate in the direction of width into the side of one surface at right angles with the one surface, and a central flange extending from the center of the sealing substrate in the direction of width into the side of one surface at right angles with the one surface; the distance between the central flange and both end flanges is slightly larger than the width of the upper flanges of the channel plates facing each other of the roof units neighboring each other; the channel plates are fastened together by bolts and nuts in a state where the central flange of the seal plate member is inserted from the upper side into between the vertical walls of the channel plates facing each other and where the sealing substrate is placed on the upper surfaces of the upper flanges of the channel plates in the neighboring roof units; and both end flanges of the seal plate member are folded in the directions to approach each other with the ends of the upper flanges of the channel plates as fulcrums.

It is desired that the frame is constituted by detachably fastening the struts and the beams together all by using bolts

and internally threaded members, or is constituted by detachably fastening the struts and the beams together, and the beams and the beams together all by using bolts and internally threaded members.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a disassembled perspective view schematically illustrating the constitution of an embodiment of a solid structure constituted according to the present invention;

Fig. 2 is a view of one side (viewing the side surface facing nearly the right lower side in Fig 1) illustrating a completed state of the solid structure shown in Fig. 1;

Fig. 3 is a view of the other side (viewing the side surface facing nearly the left lower side in Fig 1) illustrating a completed state of the solid structure shown in Fig. 1;

Fig. 4 is a view of one side illustrating a side wall unit using a frame structure only in the solid structure shown in Fig. 2;

Fig. 5 is a view of one side illustrating a frame only in the solid structure shown in Fig. 4;

Fig. 6 is a sectional view along the line A-A in Fig. 5;

Fig. 7 is a plan view partly in cross section mounting a floor unit on the frame shown in Fig. 6;

Fig. 8 is a sectional view illustrating, on an enlarged scale, a portion B in Fig. 6;

Fig. 9 is a side sectional view of when a coupling structure shown in Fig. 8 is viewed from the lower side, and is a sectional view illustrating the portion B in Fig. 5 on an enlarged scale;

Fig. 10 is a plan view illustrating a major portion of the coupling structure shown in Fig. 8 in a disassembled manner;

Fig. 11 is a plan view illustrating a portion C in Fig.

6 on an enlarged scale;

Fig. 12 is a side view illustrating the coupling structure shown in Fig. 11 as viewed from the lower side in Fig. 11;

Fig. 13 is a sectional view illustrating a portion D in Fig. 5 on an enlarged scale;

Fig. 14 is a plan sectional view illustrating the coupling structure shown in Fig. 13;

Fig. 15 is a side sectional view illustrating the floor unit shown in Fig. 7 as viewed from the direction of width, and is a side sectional view illustrating the frame structure only of the floor unit;

Fig. 16 is a sectional view illustrating a coupling structure of the floor unit, intermediate beam and side beam facing the intermediate beam in Fig. 7, and illustrates, on an enlarged scale, the coupling structure at a position denoted by a code M12;

Fig. 17 is a plan view of a coupling structure shown in Fig. 16;

Fig. 18 is a plan view illustrating, on an enlarged scale, the constitution of a corner portion (left lower corner in Fig. 4) of the side wall unit shown in Fig. 4 and of hollow mounting members arranged at the neighboring side edges thereof;

Fig. 19 is a side view illustrating, in a partly omitted manner, the constitution shown in Fig. 18 as viewed from the left in Fig. 18;

Fig. 20 is a sectional view illustrating the constitution of a coupling portion of the side beam designated at H in Figs. 5 to 7 for the side wall unit in a state of being assembled and in a state of being disassembled;

Fig. 21 is a plan view of a coupling portion (assembled state) of the side beam shown in Fig. 20;

Fig. 22 is a sectional view along the line E-E in Fig.

4;

Fig. 23 is a longitudinal sectional view of Fig. 22;

Fig. 24 is a transverse sectional view illustrating the constitution of a coupling portion of the corner strut designated at U in Figs. 5 and 13 for the side wall unit;

Fig. 25 is a sectional view illustrating a portion F in Fig. 4 on an enlarged scale;

Fig. 26 is a perspective plan view schematically illustrating a state where roof units are mounted on the upper ends of the frame illustrated in Figs. 1 and 5;

Fig. 27 is a side sectional view of when an intermediate roof unit is viewed from the direction of width, and is a side sectional view also illustrating a corresponding upper side beam;

Fig. 28 is a plan view of the intermediate roof unit shown in Fig. 27 and illustrates the constituent members in a partly omitted manner;

Fig. 29 is a sectional view illustrating a portion of Fig. 27 on an enlarged scale;

Fig. 30 is a sectional view along the line G-G in Fig. 27;

Fig. 31 is a view illustrating the roof units shown in Fig. 4 on an enlarged scale, and also shows the corresponding upper side beam;

Fig. 32 is a side view of when a roof unit of the one side positioned on the left side in Fig. 31 is viewed from the left in Fig. 31, and also shows the corresponding upper side beam;

Fig. 33 is a disassembled perspective view schematically illustrating the constitution of another embodiment of the solid structure constituted according to the present invention;

Fig. 34 is a view of one side (viewing the side surface

facing nearly the left lower side in Fig 33) illustrating a completed state of the solid structure shown in Fig. 33;

Fig. 35 is a side view of the solid structure of Fig. 34 illustrating the roof units in cross section, illustrating the side wall units by a frame structure only, and illustrating portions thereof on an enlarged scale;

Fig. 36 is a view of the other side (viewing the side wall facing nearly the left upper side in Fig 33) illustrating a completed state of the solid structure shown in Fig. 33;

Fig. 37 is another side view of the solid structure shown in Fig. 36, and illustrates a state where the roof unit is disassembled toward the upper side, the side wall unit is illustrated by the frame structure only, and a shutter is removed;

Fig. 38 is a view of the other side (viewing the side wall facing nearly the right lower side in Fig 33) illustrating a completed state of the solid structure shown in Fig. 33, and is a view of the other side illustrating the side wall unit at the right end by the frame structure only;

Fig. 39 is a sectional view along the line J-J in Fig. 38;

Fig. 40 is a plan view illustrating the upper end only of the frame included in the solid structure shown in Fig. 33;

Fig. 41 is a sectional view along the line M-M in Fig. 40, and illustrates a state where the roof units are mounted and a portion thereof on an enlarged scale;

Fig. 42 is a sectional view along the line N-N in Fig. 40, and illustrates a state where the roof unit is mounted;

Fig. 43 is a view illustrating, partly on an enlarged scale, a coupling portion coupling the side wall unit, the corner strut and the upper side beam;

Fig. 44 is a perspective plan view schematically illustrating a state where the roof units are mounted on the

upper end of the frame shown in Figs. 33 and 40;

Fig. 45 is a sectional view along the line P-P in Fig. 44, and illustrates a state where the roof units are separated upward from the frame, and a portion of the frame partly on an enlarged scale;

Fig. 46 is a sectional view illustrating, partly on an enlarged scale, the roof units of Fig. 45;

Fig. 47 is a perspective view schematically illustrating the left end portion of the roof unit of Fig. 45 on an enlarged scale;

Fig. 48 is a plan view of the roof unit of Fig. 45;

Fig. 49 is a side view schematically illustrating the roof unit of Fig. 48 as viewed from a direction of width;

Fig. 50 is a plan view illustrating a portion of a roof unit of one side and a trough unit of one side in a disassembled manner;

Fig. 51 is a sectional view illustrating a state of coupling the trough unit of one side shown in Fig. 50, the roof unit of one side and the upper side beam, and is a sectional view corresponding to the sectional view along the line Q-Q in Fig. 44;

Fig. 52 is a perspective view schematically illustrating a portion of Fig. 51;

Fig. 53 is a sectional view of a seal plate member arranged between the roof units neighboring each other;

Fig. 54 is a sectional view illustrating a state of using the seal plate member shown in Fig. 53; and

Fig. 55 is a disassembled perspective view schematically illustrating the constitution of a further embodiment of the solid structure constituted according to the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Preferred embodiments of the solid structure

constituted according to the present invention will now be described in further detail with reference to the accompanying drawings. The solid structure according to the present invention includes novel coupling structures among the constituent elements (e.g., a coupling structure between a strut and a beam, a coupling structure between a beam and a beam, a coupling structure between a side wall unit and a frame, a coupling structure between a floor unit and the frame, and a coupling structure between a roof unit and the frame), as well as novel constituent elements (e.g., a frame, a floor unit, a side wall unit, and a roof unit). As other objects of the invention, therefore, there can be provided novel coupling structures among the constituent elements of the solid structure, and constituent elements of the solid structure, that are capable of achieving the above-mentioned objects.

Referring to Figs. 1, 5, 6 and 26, the solid structure constituted according to the present invention has a frame 2 that forms a solid space of substantially a rectangular parallelopiped shape. The frame 2 includes four struts 4, 6, 7 and 8 arranged in a rectangular shape as viewed on a plane, side beams 10, 12, 14 and 16 that extend horizontally to couple the struts 4, 6, 7 and 8, an inner side beam 18 that horizontally extends to couple the side beams 12 and 16 that are facing each other, and upper side beams 20, 22, 24 and 26 for coupling the upper ends of the struts 4, 6, 7 and 8. In this embodiments, the struts 4, 6, 7 and 8 are arranged at four corners of the frame 2, and are, hence, called corner struts 4, 6, 7 and 8 in the following description.

The corner struts 4, 6, 7 and 8 are constituted by metallic square pipes having a square shape in cross section, and, in this embodiment, are constituted steel pipes of an ortho-square shape, which are common parts. Base plates of a rectangular shape are integrally secured to the lower ends

of the corner struts 4, 6, 7 and 8 by welding. The corner struts 4, 6, 7 and 8 are erected being either detachably secured onto a foundation via the base plates or placed on the ground G. The corner struts 4 and 6 facing each other are coupled by the side beam 10 at an intermediate position in the up-and-down direction, and the upper ends of the corner struts 4 and 6 are coupled together by the upper side beam 20. The corner struts 6 and 7 facing each other are coupled by the side beam 12 at an intermediate position in the up-and-down direction, and the upper ends of the corner struts 6 and 7 are coupled together by the upper side beam 22. The corner struts 7 and 8 facing each other are coupled by the side beam 14 at an intermediate position in the up-and-down direction, and the upper ends of the corner struts 7 and 8 are coupled together by the upper side beam 24. The corner struts 4 and 8 facing each other are coupled by the side beam 16 at an intermediate position in the up-and-down direction, and the upper ends of the corner struts 4 and 8 are coupled together by the upper side beam 26. The side beams 12 and 16 facing each other in the horizontal direction are coupled by the inner side beam 18 at an intermediate position in the lengthwise direction. The side beams 10, 12, 14, 16 and the inner side beam 18 are, respectively, H-beams having a web, an upper flange and a lower flange, which are common parts. The upper side beams 20, 22, 24 and 26 are constituted by metallic pipes of a square shape in cross section and, in this embodiment, are constituted by steel pipes of an ortho-square shape in cross section, which are common parts. The constituent elements of the frame 2 are all detachably coupled together by using bolts and internally threaded members. The coupling structures for them will be described later.

A side edge space of a rectangular shape is formed in each of a plurality of side edge regions formed in the frame

2 or, in this embodiment, in each of the four side edge regions. That is, in a first side edge region, there is formed a rectangular side edge space S1 surrounded by the upper side beam 20 and the side beam 10 facing each other in the up-and-down direction, and surrounded by the corner struts 4 and 6 facing each other in the horizontal direction. In a second side edge region, there is formed a rectangular side edge space S2 surrounded by the upper side beam 22 and the side beam 12 facing each other in the up-and-down direction, and surrounded by the corner struts 6 and 7 facing each other in the horizontal direction. In a third side edge region, there is formed a rectangular side edge space S3 surrounded by the upper side beam 24 and the side beam 14 facing each other in the up-and-down direction, and surrounded by the corner struts 7 and 8 facing each other in the horizontal direction. In a fourth side edge region, there is formed a rectangular side edge space S4 surrounded by the upper side beam 26 and the side beam 16 facing each other in the up-and-down direction, and surrounded by the corner struts 4 and 8 facing each other in the horizontal direction. In the side edge spaces S1 to S4, rectangular side wall units 30, 32, 34 and 36 are fitted and detachably coupled by using bolts and internally threaded members. The constitutions of the side wall units 30, 32, 34 and 36 and the coupling structure to the frame 2 will be described later.

The frame 2 includes a floor space F1 surrounded by four beams, i.e., surrounded by the side beams 10, 12 and 16 and by the inner side beam 18, and a floor space F2 surrounded by four beams, i.e., surrounded by the side frames 12, 14 and 16 and by the inner side beam 18. Rectangular floor units 38 having substantially the same shape and the same size are mounted on the floor spaces F1 and F2 having substantially the same shape and the same size, and are detachably coupled thereto by using bolts and internally threaded members. Constitution

of the floor units 38 and the coupling structure to the frame 2 will be described later.

The frame 2 includes upper side beams 20, 22, 24 and 26 that couple the upper ends of the corner struts 4, 6, 7 and 8 facing each other, and that define rectangular peripheral edges of the frame together with the corner struts 4, 6, 7 and 8 as viewed on a plane. The frame 2 includes a rectangular upper space R1 surrounded by the corner struts 4, 6, 7 and 8 and by the upper end beams 20, 22, 24 and 26. A plurality of or, in this embodiment, three rectangular roof units 40, 42 and 44 are mounted on the upper ends of the frame 2 so as to cover the upper end space R1 from the upper side, and are detachably coupled by using bolts and internally threaded members. The constitution of the roof units 40, 42 and 44 and the coupling structure to the frame 2 will be described later.

Next, described below is a structure for coupling the side beams 10 and 16 to the strut 4 of the frame 2. Referring to Figs. 8 to 10, the corner strut 4 arranged at a corner of the frame 2 is constituted by a square steel pipe having an ortho-square shape in cross section. Ends of the side beams 10 and 16 constituted by H-beams having a web W, an upper flange UF and a lower flange LF are coupled to the inner side walls 46 and 47 of the corner strut 4 that are meeting at right angles with each other and that are facing in the horizontal direction along the side edges of the frame 2 meeting at right angles with each other. A plurality of pairs (two pairs in this embodiment) of first internally threaded members 50 are arranged between the inner side wall 46 which is one of the inner side walls 46 and 47 of the corner strut 4 and the outer side wall 48 positioned on the side opposite to the one inner side wall 46 maintaining a distance in the up-and-down direction, the plurality of first internally threaded members 50 extending in parallel at the same height maintaining a

distance in the horizontal direction and forming internally threaded holes 52 at one end thereof in a manner that the internally threaded holes 52 are opened in the outer surface of the one inner side wall 46. A pair of through holes 54 are formed in each pair of the first internally threaded members 50 that have substantially the same shape and the same size, the pair of through holes 54 maintaining a distance in the axial direction, meeting the axes horizontally at right angles, and extending in parallel with each other.

Through holes are formed in one inner side wall 46 and in one outer side wall 48 that are facing each other of the corner strut 4 at positions where the first internally threaded members 50 are mounted, the through holes having their own common axes, and the first internally threaded members 50 are secured by welding in a state of being fitted to their corresponding through holes. The surfaces of the first internally threaded members 50 at one end thereof are in flush with the outer surface of the one inner side wall 46, and the surfaces of the first internally threaded members 50 at the other end thereof are in flush with the outer surface of the one outer side wall 48. The first internally threaded members 50 are formed by cutting a metallic round rod and have the same diameter from one end thereof up to the other end thereof.

A plurality of pairs (two pairs in this embodiment) of second internally threaded members 56 are arranged between the other inner side wall 47 which is one of the inner side walls 46 and 47 of the corner strut 4 and the other outer side wall 49 positioned on the side opposite to the other inner side wall 47 maintaining a distance in the up-and-down direction, the plurality of second internally threaded members 56 having axes common to the pair of axes of the through holes 54 formed in each pair of the first internally threaded members 50 and having internally threaded holes 55 at one end thereof in a manner

to penetrate through the corresponding pair of through holes 54 of the first internally threaded members 50 and are opened in the outer surface of the other inner side wall 47. Each of the second internally threaded members 56 having substantially the same shape and the same size includes a round rod portion 56a of a relatively small diameter that fits to the corresponding through hole 54 and a cylindrical portion 56b of a relatively large diameter coupled to an end of the round rod portion 56a, and an internally threaded hole 55 is formed in the cylindrical portion 56b. The cylindrical portion 56b is closed at a portion where it is connected to the round rod portion 56a. The second internally threaded members 56 can be formed by cutting a metallic round rod. The cylindrical portion 56b of the second internally threaded member 56 has a diameter same as that of the first internally threaded member 50, and the internally threaded hole 55 in the cylindrical portion 56b has an inner diameter same as that of the internally threaded hole 52 in the first internally threaded member 50. This constitution makes it possible to use externally threaded bolts having the same outer diameter (externally threaded bolts having the same nominal count), i.e., to use common bolts (in this embodiment, bolts of a nominal count M16 specified under the JIS) for the first internally threaded members 50 and for the second internally threaded members 56.

Through holes are formed in the other inner side wall 47 and in the other outer side wall 49 that are facing each other of the corner strut 4 on the axes of the through holes 54 formed in the first internally threaded members 50. The through holes formed in the other outer side wall 49 have a relatively small diameter so as to be fitted with the round rod portions 56a of the second internally threaded members 56, and the through holes formed in the other inner side wall 47

have a relatively large diameter so as to be fitted with the cylindrical portions 56b of the second internally threaded members 56. The second internally threaded members 56 are secured by welding in a state where the round rod portions 56a are fitted into the through holes formed in the other outer side wall 49 penetrating through the through holes 54 of the corresponding first internally threaded members 50, and the cylindrical portions 56b are fitted into the through holes formed in the other inner side wall 47. The end surfaces at one end of the second internally threaded members 56 (surfaces on one side of the cylindrical portions 56b) are in flush with the outer surface of the other inner side wall 47, and end surfaces at the other end of the second internally threaded members 56 (surfaces on the other side of the round rod portions 56a) are in flush with the outer surface of the other outer side wall 49.

Rectangular coupling plates 58 are secured by welding to the ends of the side beams 10 and 16 which are H-beams at right angles with the side beams 10 and 16. A plurality (two in this embodiment) of mounting holes 59 are formed in the coupling plates 58 on each side divided by the web W maintaining a distance in the up-and-down direction.

The one side beam 10 has the coupling plate 58 that is substantially brought into contact with the one inner side wall 46 of the corner strut 4 via a rectangular flat plate 60 in a manner that the mounting holes 59 of the coupling plate 58 are in alignment with the internally threaded holes 52 of the pairs of the first internally threaded members 50 opened in the one inner side wall 46 of the corner strut 4. The one side beam 10 is detachably fastened to the one inner side wall 46 of the corner strut 4 by bringing the bolts 62 into engagement with the internally threaded holes 52 through washers 64, mounting holes 59 and through holes in the flat plate 60.

The other side beam 16 has the coupling plate 58 that is substantially brought into contact with the other inner side wall 47 of the corner strut 4 via a rectangular flat plate 60 in a manner that the mounting holes 59 of the coupling plate 58 are in alignment with the internally threaded holes 55 of the pairs of the second internally threaded members 56 opened in the other inner side wall 47 of the corner strut 4. The other side beam 16 is detachably fastened to the other inner side wall 47 of the corner strut 4 by bringing the bolts 62 into engagement with the internally threaded holes 55 through washers 64, mounting holes 59 and through holes in the flat plate 60.

The pair of the first internally threaded members 50 and the pair of the second internally threaded members 56 are arranged in the corner strut 4 so as to intersect each other at the same height, enabling the one side beam 10 and the other side beam 16 which are the same H-beams having the substantially same shape and the same size in cross section and meeting at right angles to be positioned and detachably fastened by bolts at substantially the same height or, in other words, on substantially a common plane. As a result, the assembling operation is facilitated and quickened and, besides, common parts can be used to decrease the cost. Besides, the pair of the first internally threaded members 50 and the pair of the second internally threaded members 56 are secured by welding in the square strut 4 which is a square steel pipe having a square shape in cross section in a manner to meet at right angles in the axial direction, maintaining a required strength of the corner strut 4. In the above coupling structure, the side beams 10 and 16 can be positioned on substantially the same plane with respect to the corner strut 4. This effect can be similarly achieved even when the side beams 10 and 16 have different heights in cross section.

Referring to Figs. 1, 5 and 6, the above coupling structure for coupling the side beam 10 and the side beam 16 to the corner strut 4 of the frame 2 can also be applied to coupling the side beams 10 and 12 to the corner strut 6, coupling the side beams 12 and 14 to the corner strut 7, and coupling the side beams 14 and 16 to the corner strut 8. The upper surfaces of the side beams 10, 12, 14 and 16 are positioned on substantially a common plane.

Next, described below is a coupling structure for coupling the side beam 16 and the inner side beam 18 of the frame 2. Referring to Figs. 1, 11 and 12, one end of the inner side beam 18 is coupled at right angles to a side portion of the side beam 16 nearly at the center in the lengthwise direction thereof, the side beam 16 coupling the corner struts 4 and 8 together. At a portion where the inner side beam 18 is coupled to the side beam 16, a support plate 70 which is a rectangular steel plate is secured by welding across the ends of the upper flange UF and the lower flange LF of the side beam 16. The support plate 70 extends on the outer side of the web W in parallel therewith maintaining a distance. A reinforcing plate 71 which is a steel plate is arranged and is secured by welding among the center of the support plate 70 in the direction of width thereof, web W, upper flange UF and lower flange LF, and extends in the up-and-down direction to meet at right angles thereto. Two mounting holes 72 are formed in the support plate 70 on either side divided by the reinforcing plate 71 maintaining a distance in the up-and-down direction. A coupling plate 73 which is a rectangular steel plate is secured by welding to an end of the inner side beam 18 at right angles with the inner side beam 18. Two mounting holes 74 are formed in the coupling plate 73 on either side divided by the web W of the inner side beam 18 maintaining a distance in the up-and-down direction.

The inner side beam 18 has the coupling plate 73 that is substantially brought into contact with the support plate 70 of the side beam 16 via an annular plate 75 in a manner that the mounting holes 54 of the coupling plate 73 are in alignment with the mounting holes 72 of the support plate 70 of the side beam 16. The inner side beam 18 is detachably fastened to the side beam 16 by protruding the bolts 76 inward of the support plate 70 of the side beam 16 through washers 77, mounting holes 74, annular plate 75, mounting holes 72 and washers 78. The other end, too, of the inner side beam 18 is coupled at right angles to the side portion of the side beam 12 at the central portion in the lengthwise direction thereof, the side beam 12 coupling the corner struts 6 and 7 together. The upper surfaces of the side beams 16 and 12 and the upper surface of the inner side beam 18 are positioned on a substantially common plane. The inner side beam 18 is constituted by an H-beam having substantially the same shape and the same size as those of the side beams 10, 12, 14 and 16. Thus, the inner side beam 18 and the side beams 16, 12, too, are detachably coupled easily, reliably and quickly by using bolts 76 and nuts 79 which are the internally threaded members. The bolts 76 are M16 which are the same as the above-mentioned bolts 62.

Next, described below is a coupling structure for coupling the upper side beams 20 and 26 to the corner strut 4 of the frame 2. Referring to Figs. 1, 13 and 14, the ends of the upper side beams 20 and 26 which in this embodiment are steel pipes of an ortho-square shape are coupled to the inner side walls 46 and 47 which are meeting at right angles with each other at the upper end of the corner strut 4, the inner side walls 46 and 47 facing each other in the horizontal direction along the side edges that meet at right angles with each other. Pairs of mounting holes 80 are formed in the upper ends of the one inner side wall 46 and in the other inner side

wall 47 of the corner strut 4 at the same height maintaining a distance in the horizontal direction. Rectangular coupling plates 81 which are steel plates are secured by welding to the ends of the upper side beams 20 and 26 coupled to the corner strut 4 at right angles with the upper side beams 20 and 26. The open ends of the upper side beams 20 and 26 are closed by the coupling plates 81. A pair of internally threaded holes 82 are formed in each coupling plate 81 at the same height maintaining a distance in the horizontal direction.

The one upper side beam 20 has the coupling plate 81 that is substantially brought into contact with the one inner side wall 46 via an annular plate 85 in a manner that the internally threaded holes 82 of the coupling plate 81 are in alignment with the mounting holes 80 of the one inner side wall 46. The one upper side beam 20 is detachably fastened to the one inner side wall 46 of the corner strut 4 by bringing the bolts 83 into engagement with the internally threaded holes 82 from upper open end of the corner strut 4 through the washers 84, mounting holes 80 and annular plate 85.

The other upper side beam 26 has the coupling plate 81 that is substantially brought into contact with the other inner side wall 47 via an annular plate 85 in a manner that the internally threaded holes 82 of the coupling plate 81 are in alignment with the mounting holes 80 of the other inner side wall 47. The other upper side beam 26 is detachably fastened to the other inner side wall 47 of the corner strut 4 by bringing the bolts 83 into engagement with the internally threaded holes 82 from upper open end of the corner strut 4 through the washers 84, mounting holes 80 and annular plate 85.

As described above, the corner strut 4 and the upper side beams 20, 26 are coupled together easily, reliably and quickly by turning the bolts from the upper open ends of the corner strut 4. The bolts 83 are M16 which are the same as the

above-mentioned bolts 62 and 76. In the frame 2, the coupling structure for coupling the corner strut 4 and the upper side beams 20 and 26 can also be applied to coupling the corner strut 6 and the upper side beams 20 and 22, coupling the corner strut 7 and the upper side beams 22 and 24, and coupling the corner strut 8 and the upper side beams 24 and 26. The upper end surfaces of the corner struts 4, 6, 8 and 10 and the upper surfaces of the upper side beams 20, 22, 24 and 26 are positioned on a substantially common plane.

As described above with reference to Figs. 1, 7 and 15 to 17, the frame 2 includes floor spaces F1 and F2, and rectangular floor units 38 are fitted into the floor spaces F1 and F2. The peripheral edges of the floor unit 38 are constituted by four frame members 86 made of steel plates. The frame members 86 having lengths corresponding to the four side edges of the floor unit 38 include a vertical wall 87 and a flange 88 extending at right angles outwards from the upper end of the vertical wall 87, and have substantially the same shape and the same size in cross section. A plurality of transverse beams 90 are extending in the direction of width in parallel maintaining a distance in the lengthwise direction of the floor unit 38 (right-and-left direction in Fig. 7) between the vertical walls 87 of the frame members 86 facing each other in the direction of width of the floor unit 38 (in the up-and-down direction in Fig. 7). Both ends of the transverse beams 90 are secured to the vertical walls 87 by welding. A plurality of longitudinal beams 92 are extending in parallel in the lengthwise direction maintaining a distance in the direction of width of the floor unit 38 between the transverse beams 90 facing each other, between the transverse beam 90 positioned at an end of the floor unit 38 in the lengthwise direction and the vertical wall 87 of the frame member 86 facing thereto, and between the transverse beam 90

positioned at the other end of the floor unit 38 in the lengthwise direction and the vertical wall 87 of the frame member 86 facing thereto. The plurality of longitudinal beams 92 are secured to their corresponding side beams 90 and to the vertical walls 87 by welding.

Upper surfaces of the metallic pipes having a square shape in cross section and substantially the same shape and the same size or, in this embodiment, of the transverse beams 90 which are the square steel pipes and the upper surfaces of the metallic pipes having a square shape in cross section and substantially the same shape and the same size or, in this embodiment, of the longitudinal beams 92 which are the square steel pipes, are positioned on a plane which is substantially common to the upper surfaces of the flanges 88. The height of the transverse beams 90 is nearly the same as the height of the frame members 86, and the height of the longitudinal beams 92 is lower than the height of the transverse beams 90. At the lower ends at both ends of the floor unit 38 in the lengthwise direction, there are arranged the transverse beams 94 so as to extend in the direction of width along the inner sides of the vertical walls 87 of the frame members 86 facing each other in the lengthwise direction of the floor unit 38. Both ends of the transverse beams 94 are secured to the vertical walls 87 of the frame members 86 of the floor unit 38 facing in the direction of width. Regions between both ends of the transverse beams 94 are secured at suitable positions by welding to the inner sides of the vertical walls 87 of the frame members 86 of the floor unit 38 facing in the lengthwise direction. The transverse beams 94 are made of metallic pipes having a square shape in cross section and substantially the same shape and the same size or, in this embodiment, are made of steel pipes having an ortho-square shape in cross section.

A plurality of horizontally extending braces 96 are

arranged in both end regions of the floor unit 38 in the lengthwise direction. The brace 96 arranged in one region in the lengthwise direction of the floor unit 38 is extending aslant from the inside at the center in the direction of width of the vertical wall 87 of the frame member 86 arranged at an end in the lengthwise direction toward the inside of the vertical wall 87 of the frame members 86 arranged on both sides in the direction of width as viewing the floor unit 38 on a plane. Further, the brace 96 arranged in the other region in the lengthwise direction of the floor unit 38 is extending aslant from the inside at the center in the direction of width of the vertical wall 87 of the frame member 86 arranged at the other end in the lengthwise direction toward the inside of the vertical wall 87 of the frame members 86 arranged on both sides in the direction of width as viewing the floor unit 38 on a plane. The braces 96 made of a metal (steel in this embodiment) are of a square shape in cross section having substantially the same shape and the same size as those of the longitudinal beams 92. The upper surfaces of the braces 96 are positioned on a plane substantially in common to the upper surfaces of the flanges 88. Onto the upper surfaces of the floor units 38, at least one floor plate or, in this embodiment, four floor plates 98 are secured by securing means such as tapping screws or an adhesive, that is not shown.

One floor unit 38 is fitted to the floor space F1 from the upper side, the peripheral flanges 88 are placed on the upper surfaces of the four beams specifying the floor space F1 or, in this embodiment, are placed on the upper surfaces of the side beams 10, 12 and 16 and of the inner side beam 18, and the vertical walls 87 are detachably fastened to their corresponding side beams 10, 12, 16 and to the inner side beam 18 by using bolts 100 and internally threaded members 102.

The coupling structures for coupling the floor unit 38

to the side beams 10, 12, 16 and to the inner side beam 18 are substantially the same. As a representative example, therefore, concretely described below is a structure for coupling the floor unit 38 to the side beam 10. At a portion where the side beam 10 which is an H-beam is coupled to the floor unit 38, a support plate 104 which is a rectangular steel plate is secured by welding between the opposing ends of the upper flange UF and the lower flange LF of the side beam 10. The support plate 104 extends on the outer side of the web W in parallel therewith maintaining a distance. Between the support plate 104 and the side surface of the web W, an internally threaded member 102 having an internally threaded hole 106 formed at one end thereof (region from one end to nearly the other end in the embodiment) is secured by welding in a manner that the internally threaded hole 106 is opened in the outer surface of the support plate 104. The internally threaded member 102 is positioned at the center in the up-and-down direction of the web W. The internally threaded member 102 can be obtained by cutting a metallic round rod and has the same diameter from one end up to the other end thereof. A mounting hole 108 is formed in the vertical wall 86 of the floor unit 38 at a position corresponding to the internally threaded hole 106 of the internally threaded member 102. The mounting hole 108 is positioned at the lower end of the vertical wall 86.

The floor unit 38 is detachably fastened to the side beam in a state where it is fitted and placed in the floor space F1 from the upper side by bringing the bolts 100 into engagement with the internally threaded holes 106 of the internally threaded members 102 through washers 110, mounting holes 108 and annular plate 112. In this embodiment, the bolts 100 are M12 mentioned above. This coupling structure is provided at four places between the floor unit 38 fitted in the floor space

F1 and the side beam 10, at four places between the floor unit 38 and the inner side beam 18, at two places between the floor unit 38 and the side beam 12, and at two places between the floor unit 38 and the side beam 16 (see portions designated at M12 in Fig. 7). A transverse beam 94 exists at the lower end of the vertical wall 86, that faces the side beams 12 and 16, of the floor unit 38 mounted on the floor space F1. Therefore, the above coupling structures inclusive of the internally threaded members 102 are arranged at positions higher than the transverse beam 94, but have the same constitution.

The above coupling structure is provided at four places between the floor unit 38 mounted in the floor space F2 and the side beam 14, at four places between the floor unit 38 and the inner side beam 18, at two places between the floor unit 38 and the side beam 12 and at two places between the floor unit 38 and the side beam 16.

As will be obvious from the foregoing description, the floor units 38 are fitted and placed in the floor spaces F1 and F2, and are detachably fastened to the side beams 10, 12, 16, to the inner side beam 18, to the side beams 12, 14, 16 and to the inner side beam 18 firmly and quickly by simply screwing the bolts 100 into the internally threaded members 102. The floor unit 38 is of a rectangular shape having substantially a constant thickness and has a very simple appearance. The floor unit 38 incorporates horizontal braces 96 integrally therewith, and features excellent quake-proof structure.

As described earlier with reference to Figs. 1, 2, 4, 18 and 19, rectangular side edge spaces S1 to S4 are formed in the four side edge regions formed by the frame 2, and side wall units 30, 32, 34 and 36 are fitted to the side edge spaces S1 to S4 and are detachably coupled thereto by using bolts and

internally threaded members. Basic constitutions of the side wall units 30, 32, 34 and 36 and coupling structures for the frame 2 are substantially the same. As representative examples, therefore, described below are the constitution of the side wall unit 30 and the coupling structure for the frame 2 in the side space S1.

Hollow mounting members 120 having a square shape in cross section (ortho-square shape in the embodiment) are integrally disposed at four corners and on the four side edges of the side wall unit 30 that has a rectangular shape on a plane. The hollow mounting members 120 having substantially the same shape and the same size are arranged with their axes directed to both surfaces of the side wall unit 38. In the embodiment illustrated in Fig. 4, the hollow mounting members 120 are disposed in a number of one at four corners, in a number of two along both side edges in the lengthwise direction, and in a number of two along both side edges in the direction of width. Figs. 18 and 19 illustrate the hollow mounting members 120 disposed at the left lower corner of the side wall unit 30 illustrated in Fig. 4 and on the side edge close thereto. The hollow mounting member 120 is constituted by four side walls having a predetermined thickness and a width in the axial direction or, in this embodiment, is constituted by four side walls 121 having the same thickness and the width in the axial direction, and is formed by cutting a metallic square pipe or, concretely, by cutting a square steel pipe. Mounting holes 122 are formed in the two side walls 121 meeting at right angles of the hollow mounting member 120 disposed at the corner, i.e., in the two side surfaces 121 facing outward of the side wall unit 30. Mounting holes 122 are formed in one side wall of the hollow mounting members 120 arranged along the side edges of the side wall unit 30 and facing outward of the side wall unit 30. Namely, in Fig. 18, mounting holes 122 are formed

in one side wall 121 of the hollow mounting member 120 arranged along the left side edge of the side wall unit 30 and facing outward on the left side of the side wall unit 30, and are formed in one side wall 121 of the hollow mounting member 120 arranged along the lower side edge of the side wall unit 30 and facing outward on the lower side of the side wall unit 30. The hollow mounting members 120 arranged at the other three corners and along the other two side edges of the side wall unit 38 have substantially the same constitution as described above and are arranged in the same manner.

The side wall unit 30 includes a plurality of side frames (e.g., side frames 124a, 124b, 124c, etc.) extending along the four side edges of the side wall unit 30, a plurality of transverse frames (e.g., transverse frames 126a, 126b, 126c, etc.) extending in the direction of width (up-and-down direction in Fig. 4), and a plurality of longitudinal frames (e.g., longitudinal frames 128a, 128b, 128c, etc.) extending in the lengthwise direction (right-and-left direction in Fig. 4), that are suitably laid out and are secured to each other by welding. The hollow mounting members 120 are secured to the frames by welding. The longitudinal frames, transverse frames and side frames are made of metallic pipes having a square shape in cross section and having substantially the same shape and the same size or, in this embodiment, are made of a steel pipe having an ortho-square shape in cross section. The hollow mounting members 120 have a width in the axial direction which is substantially the same as the width of the side frames, transverse frames and longitudinal frames. One end surfaces of the hollow mounting members 120 in the axial direction, one surface of the side wall unit 30 formed by the surfaces on one side of the side frames, transverse frames and longitudinal frames, the other end surfaces of the hollow mounting members 120 in the axial direction, the other surface

of the side wall unit 30 formed by the surfaces on the other side of the side frames, transverse frames and longitudinal frames, are positioned on substantially common planes which are in parallel with each other. The four side surfaces of the side wall unit 30 are positioned on a substantially common plane.

Two side walls meeting at right angles among the side walls 121 of the hollow mounting members 120 arranged at four corners of the side wall unit 30 or two side walls 121 facing outward of the side wall unit 30, define portions of the side walls of the side wall unit 30 meeting at right angles at the corners of the side wall unit 30, and one side wall among the side walls 12 of the hollow mounting member 120 arranged along the side edge of the side wall unit 30 or the one side wall 121 facing outward of the side wall unit 30 defines a portion of the side wall along the side edge of the side wall unit 30.

The side wall unit 30 includes two side frames 124a and 124b extending at right angles along the two side edges from the hollow mounting member 120 arranged at each corner, and brace frames 120 extending aslant relative to the two side frames 124a and 124b. A substantially right-angled triangle is formed by two side frames 124a, 124b and by the brace frames 129 as viewing the side wall unit 30 on a plane. The brace frames are made of metallic pipes having a square shape in cross section and having substantially the same shape and the same size as those of the longitudinal frames, transverse frames and side frames or, in this embodiment, are made of steel pipes having an ortho-square shape in cross section.

Referring to Fig. 2, on one surface of the side wall unit 30 having the frame constituted as described above, there are attached a plurality of boards 130a, 130b, 130c and 130d by using suitable securing means such as tapping screws or an adhesive that is not shown, as well as two windows 132. The

thus constituted side wall unit 30 is fitted to the side edge space S1, and is detachably fastened to the frame 2 by using bolts and internally threaded members.

In the pair of side beams, i.e., in the upper side beam 20 and in the side beam positioned under the upper side beam 20 and in the pair of corner struts 4 and 6 defining the side edge space S1 with reference to Figs. 5, 13, 20, 21 and 24, there are provided internally threaded members 135 having internally threaded holes 134 at one end thereof, internally threaded members 137 having internally threaded holes 136 at one end thereof and internally threaded members 139 having internally threaded holes 138 at one end thereof at positions corresponding to the mounting holes 122 of the hollow mounting members 120 facing the upper side beam 20, the side beam 10 and the pair of corner struts 4 and 6 among the hollow mounting members 120 of one or a plurality of (one in this embodiment) side wall units 30 fitted to the side edge space S1, in a manner that the internally threaded holes 134, 136 and 138 are opened in the side edge space S1.

The internally threaded members 135 are arranged at a plurality of places or, in this embodiment, at six places of the upper side beam 20 so as to extend in the vertical direction maintaining a distance in the lengthwise direction. Through holes having common axes are formed in the inner side wall and in the outer side wall of the upper side beam 20 facing each other in the vertical direction at positions where the internally threaded members 135 are mounted, the internally threaded members 135 being secured by welding (see Fig 13) in a state of being fitted in the corresponding through holes. The one end surfaces of the internally threaded members 135 (one end surfaces where the internally threaded holes 134 are opened) are positioned substantially in flush with the outer surface of the inner side wall (inner side wall facing the side

edge space S1) of the upper side beam 20, and the other end surfaces of the internally threaded members 135 are positioned substantially in flush with the outer surface of the outer side wall. The internally threaded members 135 can be formed by cutting a metallic round rod and have the same diameter from one end up to the other end. The positions of the upper side beam 20 where the internally threaded members 135 are arranged are those positions where the internally threaded members are indicated so as to extend in the vertical directions among the positions designated at U in Figs. 5 and 13. The upper side beam 20 is constituted by a steel pipe having a square shape in cross section, and the internally threaded members 135 are inserted in the through holes in a manner to meet the upper side beam 20 at right angles in the vertical direction, and are secured integrally therein by welding, contributing to enhancing the strength of the upper side beam 20.

The internally threaded members 137 are disposed in the corner struts 4 and 6 maintaining a distance in the up-and-down direction and horizontally extending in a direction in which the corner struts 4 and 6 are facing each other. Through holes having common axes are formed in the inner side wall and in the outer side wall of the corner struts 4 and 6 facing each other in the horizontal direction at positions corresponding to the positions where the internally threaded members 137 are mounted, the internally threaded members 137 being secured by welding in a state of being fitted into the corresponding through holes (see Figs. 13 and 24). The one end surfaces of the internally threaded members 137 (one end surfaces where the internally threaded holes 136 are opened) are positioned substantially in flush with the outer surface of the inner side wall (inner side wall facing the side edge space S1) of the corner struts 4 and 6, and the other end surfaces of the internally threaded members 137 are positioned substantially

in flush with the outer surface of the outer side wall. The internally threaded members 137 can be formed by cutting a metallic round rod and have the same diameter from one end up to the other end. The positions of the corner struts 4 and 6 where the internally threaded members 137 are arranged are those positions designated at U in Figs. 5 and 13. The corner struts 4 and 6 are constituted by steel pipes having a square shape in cross section, and the internally threaded members 137 are inserted in the through holes in a manner to meet the corner struts 4 and 6 at right angles in the horizontal direction, and are secured integrally therein by welding, contributing to enhancing the strength of the corner struts 4 and 6.

Referring to Figs. 5, 6, 20 and 21, mounting holes 140 are formed in the side beam 10 at positions corresponding to the mounting holes 122 of the hollow mounting members 120 of the side wall unit 30, the mounting holes 140 being in concentric with the axes that pass through the center of the web W in the direction of width and meet the upper and lower flanges UF and LF at right angles, and the mounting holes 140 further extending up to the upper end of the web W from the upper surface of the upper flange UF. The internally threaded holes 138 are inserted in the corresponding mounting holes in a manner that the internally threaded holes 138 are opened in the upper surface of the upper flange UF, and are secured therein by welding. The internally threaded members 139 are formed by cutting a metallic round rod and have the same diameter from one end up to the other end. The internally threaded holes 138 are formed from the ends on one side of the corresponding internally threaded members 139 up to near the other ends thereof. In the side beam 10 positioned under the upper side beam 20, the internally threaded members 139 are disposed at positions designated at U in Figs. 5 and 6. As

described above, though the mounting holes are formed in the side beam 10 which is the H-beam, a required strength of the H-beam is maintained since the mounting holes 140 are relatively short and the internally threaded members 139 are inserted and are firmly welded therein.

Referring to Figs. 4, 13, 22, 23 and 25, when the side wall unit 30 is fitted into the side edge space S1, the mounting holes 122 of the hollow mounting members 120 are brought into alignment with the internally threaded holes 134, 136 and 138 of the corresponding internally threaded members 135, 137 and 139. In this state, the bolts 141 are brought into engagement with the corresponding internally threaded holes 134, 136 and 138 of the internally threaded members 135, 137 and 139 through washers 143, mounting holes and annular plates 143, so that the side wall unit 130 is detachably fastened to the upper side beam 20, to the pair of corner struts 4 and 6, and to the side beam 10. The bolts 141 that are used are M12. Though not illustrated, the state of coupling the hollow mounting members 120 to the internally threaded members 135 is substantially the same as the state of coupling the hollow mounting members 120 to the internally threaded members 137 (see Fig. 25).

Even when the boards 130a to 130d are arranged on the outer side surface of the side wall unit 30 in a state where the side surface unit 30 is fitted into the side edge space S1, the hollow mounting members 120 are opened in the solid space of the frame 2, making it possible to accomplish the fastening to the frame 2 easily, reliably and quickly by utilizing the hollow mounting members 120 and by using the bolts 141 and the internally threaded members 135, 137 and 139. The side wall unit 30 is formed in a rectangular shape having nearly a constant thickness, and is simple in appearance and can be easily transported and stored. The brace frame 129 is integrally incorporated in the corner regions of the side wall

unit 30 to maintain excellent quake-proof structure. In a state where the side wall unit 30 is fitted into the side edge space S1, the corner struts 4 and 6 and the upper side beam 20 exhibit increased strengths since the internally threaded members 135 and 137 have been buried therein among the corner struts 4, 6, upper side beam 20 and the side beam 10 specifying the side edge space S1. When the side wall unit 30 is fastened by bolts 141, therefore, the frame 2 exhibits increased strength due to the cooperation among the side wall unit 30, corner struts 4 and 6, upper side beam 20 and side beam 10. After the side wall unit 30 is fastened to the frame 2, suitable boards can be mounted on the inner side surface of the side wall unit 30.

The basic constitutions of the other side wall units 32, 34 and 36 (basic constitution inclusive of the hollow mounting members 120) and the coupling structure to the frame 2, are substantially the same as the above-mentioned constitution of the side wall unit 30 and the coupling structure for the frame 2, and are not described here. Constitutions of frames of other side wall units 32, 34 and 36 are suitably formed depending upon the shape of the window, arrangement and installation of a door. Fig. 3 illustrates a side wall unit 36. In the side wall unit 36, there are arranged a window 132 and a slide-type door 144. Boards 145a, 145b, 145c and 145d are arranged on other outer surfaces. The constitution of the frame of the side wall unit 36 is suitably set to meet the above layout. However, the basic constitution is the same as that of the side wall unit 30 arranging the hollow mounting members 120 at the corners and along the side edges.

Referring to Figs. 1 and 26, the frame 2 forms the upper space R1, and a plurality of or, in this embodiment, three rectangular roof units 40, 42 and 44 which are longitudinally elongated are mounted on the upper end of the frame 2 so as

to cover the upper space R1 from the upper side, and are detachably coupled by using bolts and internally threaded members. In the following description, the roof unit 40 positioned on one side (left side in Fig. 26) in a direction in agreement with the direction of width (right-and-left direction in Fig. 26) of the roof units 40, 42 and 44 in the upper space R1, is called roof unit 40 of the one side, the roof unit 44 positioned on the other side (right side in Fig. 26) in the direction in agreement with the direction of width of the upper space R1 is called the roof unit 44 of the other side, and the roof unit 42 positioned between the roof unit 40 of the one side and the roof unit 44 of the other side is called the intermediate roof unit 42.

First, the constitution of the intermediate roof unit 42 and the coupling structure to the frame 2 will be described. Referring to Figs. 27 to 30, the intermediate roof unit 42 has four channel plates 160 which define the peripheral edges being arranged in a rectangular shape and having open ends that are directed inward. The channel plates 160 have substantially the same shape and the same size in cross section, and have a vertical wall 160a, and upper flange 160b and a lower flange 160c that are folded inward at right angles from the upper end and the lower end of the vertical wall 160a. The channel plates 160 are made of a suitable metal plate or, in this embodiment, a steel plate.

A plurality of transverse beams 162 and 163 are arranged between the vertical walls 160a of the channel plate 160 facing in the direction of width of the intermediate roof unit 42 (up-and-down direction in Fig. 28) maintaining a distance in the lengthwise direction of the intermediate roof unit 42 in a manner of gradually increasing the height in the lengthwise direction of the intermediate roof unit 42 from a position close to one end (left end in Fig. 28) through up to a position close

to the other end (right end in Fig. 28). Among the transverse beams 162 and 163 horizontally extending, the transverse beams 163 are made of square metallic pipes or, in this embodiment, square steel pipes having substantially the same shape and the same size and having a square shape in cross section (square shape longitudinally elongated in the up-and-down direction), and their ends are secured by welding to the vertical walls 160a of the corresponding channel plates 160, excluding the transverse beams 162 that are arranged at positions closest to the one end and to the other end in the lengthwise direction. The upper surfaces of the transverse beams 163 are positioned on a common inclined surface. The transverse beams 162 arranged at the positions closest to the ends in the lengthwise direction are made of square metal pipes or, in this embodiment, square steel pipes having a square shape larger than that of the transverse beams 163 (square shape broadened in the horizontal direction), and their both ends are secured by welding to the vertical walls 160a of the corresponding channel plates 160. The same transverse beam 163 is arranged in the same manner at a position after the second transverse beam 163 from the other end in the lengthwise direction.

Under several transverse beams 162, reinforcing transverse beams 164 are secured by welding to the vertical walls 160a of the channel plates 160 facing in the direction of width. The transverse beams 164 are made of square metallic pipes or, in this embodiment, square steel pipes having an ortho-square shape in cross section having the same width as the width of the transverse beams 162 in the horizontal direction . Between the transverse beams 164 and the transverse beams 163, there are arranged a plurality of reinforcing plates 165 maintaining a distance in the lengthwise direction so as to extend in the vertical direction, and are secured by welding. On the lower surfaces of the

transverse beams 163 at positions lower than the transverse beams 163 for which the reinforcing plates 165 are arranged, there are arranged a plurality of reinforcing plates 166 maintaining a distance in the lengthwise direction so as to hang down from the lower surfaces and are secured by welding. Reinforcing plates 167 are secured by welding to the lower ends of the reinforcing plates 166 so as to horizontally extend in the direction of width. At the center of the intermediate roof unit 42 in the direction of width, there are linearly arranged a plurality of longitudinal beams 168 in the lengthwise direction. The longitudinal beams 168 are arranged at the lower ends of the intermediate roof unit 42, and are secured by welding to the transverse beams 162, transverse beams 163, and to the vertical walls 160a of the channel plates 160 existing at the other end in the lengthwise direction.

In the inner regions of the transverse beams 162 facing each other, there are integrally arranged a plurality of braces 169 extending aslant as viewed on a plane from the inner sides at both ends of the transverse beams 162 toward the longitudinal beams 168. As viewing the intermediate roof unit 42 on a plane, a triangle is formed by the transverse beams 162 and by the braces 169 extending from the inner sides thereof. The braces 169 and the longitudinal beams 168 are made of square metallic pipes or, in this embodiment, square steel pipes having substantially the same shape and the same size and having an ortho-square shape in cross section. Thus, the intermediate roof unit 42 incorporates the braces 169 integrally therewith to maintain a required strength and exhibits a simple appearance. The lower surfaces of the braces 169, reinforcing plates 167, reinforcing transverse beams 164, transverse beams 162 and longitudinal beams 168 are positioned on substantially the same plane as the lower surfaces of the lower flanges 160c of the channel plates 160.

A trough member 170 is arranged at one end in the lengthwise direction of the intermediate roof unit 42. The trough member 170 comprises a channel-shaped metal plate or, in this embodiment, is a steel plate that is opened upward, and is provided between the transverse beam 162 arranged at one end in the lengthwise direction and the vertical wall 160a of the channel plate 160 existing at the one end or the vertical wall 160a of the channel plate 160 facing in the direction of width. The trough member 170 is secured by welding to the vertical wall 160a and to the transverse beam 162. A drain port 172 is formed in the bottom of the trough member 170. At least one roof plate 174 or, in this embodiment, a plurality of roof plates 174 are mounted on the transverse beams 163 extending from the other end up to the one end of the intermediate roof unit 42 in the lengthwise direction thereof in a manner of being inclined downward. The upper surfaces of the roof plates 174 are existing substantially on a common inclined plane. One end of each roof plate 174 having the smallest height in the lengthwise direction thereof is positioned on the trough member 170, and the one end inclusive of the above one end is placed on the upper surface of the transverse beam 162 neighboring the trough member 170.

Referring to Figs. 26, 27 to 29 and 31, end-engaging flange means 180 are arranged on the lower surfaces at both ends in the lengthwise direction of the intermediate roof unit 42 hanging from the lower surface and extending substantially the whole range in the direction of width. Each end-engaging flange means 180 is constituted by a pair of end-engaging flanges 181 and 182 that hang down from the lower surfaces at both ends in the lengthwise direction of the intermediate roof unit 180 and extend in parallel in the direction of width maintaining a distance in the lengthwise direction. The upper ends of the pair of end-engaging flanges 181 and 182 are forming

mounting portions 181a and 182a that are extending at right angles in the directions to approach each other, and the mounting portions 181a and 182a are secured by welding to the lower surface of the corresponding transverse beam 162. A plurality of or, in this embodiment, three mounting holes 183 having common axes are formed in the end-engaging flanges 181 and 182 of the end-engaging flange means 180. The distance between the end-engaging flanges 181 and 182 of each end-engaging flange means 180 is slightly greater than the width of the upper side beams 24 and 20. The end-engaging flanges 181 and 182 of the end-engaging means 180 may be formed integrally together.

Referring to Figs. 26, 31 and 32, end-engaging flange means 180 are arranged on the lower surfaces at both ends in the lengthwise direction of the roof unit 42 of the one side hanging from the lower surface and extending from the one side in the direction of width (left side in Figs. 26 and 31) up to the other side in the direction of width (right side in Figs. 26 and 31). One side-engaging flange means 190 is arranged on the lower surface of the roof unit 40 of the one side on the one side thereof in the direction of width hanging from the lower surface on the one side thereof in the direction of width and extending in the lengthwise direction. The one side-engaging flange means 190 has substantially the same constitution as the above end-engaging flange means 180 (hereinafter, the portions substantially the same as those of the end-engaging flange means 180 are denoted by the same reference numerals). The length of the one side-engaging flange means 190 is nearly the same as that of the upper side beam 26, and the distance between the one side-engaging flanges 181 and 182 of the one side-engaging flange means 190 is slightly greater than the width of the upper side beam 26. In other respects, the roof unit 40 of the one side has

substantially the same constitution as that of the intermediate roof unit 42, and is not described.

End-engaging flange means 180 are arranged on the lower surfaces at both ends in the lengthwise direction of the roof unit 42 of the other side hanging from the lower surface and extending from the other side in the direction of width (right side in Figs. 26 and 31) up to the one side in the direction of width (left side in Figs. 26 and 31). Other side-engaging flange means 192 is arranged on the lower surface of the roof unit 40 of the other side on the other side thereof in the direction of width hanging from the lower surface on the other side thereof in the direction of width and extending in the lengthwise direction. The other side-engaging flange means 192 has substantially the same constitution as the above end-engaging flange means 180 (hereinafter, the portions substantially the same as those of the end-engaging flange means 180 are denoted by the same reference numerals). The length of the other side-engaging flange means 192 is nearly the same as that of the upper side beam 22, and the distance between the other side-engaging flanges 181 and 182 of the other side-engaging flange means 192 is slightly greater than the width of the upper side beam 22. In other respects, the roof unit 40 of the other side has substantially the same constitution as that of the intermediate roof unit 42, and is not described.

Referring to Figs. 5, 13, 14 and 26, internally threaded members 195 extending in a horizontal direction to face each other and forming internally threaded holes 194 at the one end and/or the other end thereof or, in this embodiment, at the one end thereof, are buried in the portions of the upper side beams 20 and 24 defining a pair of side edges facing each other of the frame 2 coupled to the roof unit 40 of the one side, to the intermediate roof unit 42 and to the roof unit 44 of

the other side, in a manner that the internally threaded holes 194 are opened in the inner side walls of the corresponding upper side beams 20 and 24 facing the upper space R1. Further, internally threaded members 195 extending in a horizontal direction facing each other and forming internally threaded holes 194 at one end and/or the other end thereof or, in this embodiment, at one end thereof, are buried in the portions of the upper side beams 26 and 22 defining another pair of side edges facing each other of the frame 2 coupled to the roof unit 40 of the one side or to the roof unit 44 of the other side, in a manner that the internally threaded holes 194 are opened in the inner side walls of the corresponding upper side beams 26 and 22 facing the upper space R1. The constitution of the internally threaded members 195 and the mounting state are substantially the same as the constitution of the internally threaded members 137 and the mounting state thereof described above, and are not repeated here. The upper side beams 20, 22, 24 and 26 are constituted by steel pipes of a square shape in cross section, and the internally threaded members 195 are inserted in the through holes so as to meet the upper side beams 20, 22, 24 and 26 at right angles in the horizontal direction, and are secured therein integrally by welding contributing to increasing the strength of the upper side beams 20, 22, 24 and 26.

The roof unit 40 of the one side, the intermediate roof unit 42 and the roof unit 44 of the other side are placed at their both ends in the lengthwise direction on the upper side beams 20 and 24, and the pairs of end-engaging flanges 181 and 182 of the end-engaging flange means 180 are positioned being overlapped on the inner sides and the outer sides of the upper side beams 20 and 24, and are detachably fastened from the inner sides by using bolts 196 (see Fig. 29) and internally threaded members 195. Further, the one side-engaging flanges 181 and

182 of the one side-engaging flange means 190 of the roof unit 40 of the one side are positioned being overlapped on the inner side and the outer side of the upper side beam 26, and the other side-engaging flanges 181 and 182 of the other side-engaging flange means 192 of the roof unit 44 of the other side are positioned being overlapped on the inner side and the outer side of the upper side beam 22, and are, respectively, detachably fastened by bringing the bolts 196 into engagement with the internally threaded members 195 from the inner sides through washers that are not shown. The roof unit 40 of the one side, the intermediate roof unit 42 and the roof unit 44 of the other side are neighboring each other in the direction of width and are mounted on the frame 2 so as to cover the end space R1 from the upper side. The rectangular peripheral edges of the roof units 40, 42 and 44 protrude outward in the horizontal direction from the upper peripheral edges of the frame 2 to constitute eaves.

When the internally threaded holes 194 are formed at both ends of the internally threaded members 195, the internally threaded holes 194 are opened in the outer surfaces of the inner side walls and in the outer surfaces of the outer side walls of the corresponding upper side beams 20, 22, 24 and 26 facing the upper space R1. Therefore, the end-engaging flange means 180, one side-engaging flange means 190 and other side-engaging flange means 192 of the roof units 40, 42 and 44, are fastened to the inner side walls and to the outer side walls by bolts 196. In the above embodiment, further, end-engaging flange means 180 of the roof units 40, 42 and 44 are each constituted by a pair of end-engaging flanges 181 and 182. According to another embodiment, however, the end-engaging flange means 180 may be constituted by one end-engaging flange 181 or 182 hanging down from the lower surface at both ends in the lengthwise direction of the roof units 40, 42 and 44.

In the case of this embodiment, the end-engaging flange 181 or 182 is positioned being overlapped on the inner side or the outer side of the upper side beams 24 and 20, and is fastened by bolts 196 from the inner side or the outer side. According to another embodiment, similarly, the one side-engaging flange means 190 may be constituted by one side-engaging flange 181 or 182 hanging down from the lower surface on one side in the direction of width of the roof unit 40 of the one side. In the case of this embodiment, the one side-engaging flange 181 or 182 is positioned being overlapped on the inner side or the outer side of the upper side beam 26, and is fastened by bolts 196 from the inner side or the outer side. Further, according to another embodiment, the other side-engaging flange means 192 may be constituted by the other side-engaging flange 181 or 182 hanging down from the lower surface on the other side in the direction of width of the roof unit 44 of the other side. In the case of this embodiment, the other side-engaging flange 181 or 182 is positioned being overlapped on the inner side or the outer side of the upper side beam 22, and is fastened by bolts 196 from the inner side or the outer side.

Referring to Fig. 29, at least one ceiling panel member 197 is secured by, for example, tapping screws 198 to the lower surface of the intermediate roof unit 42 on at least the inner region of the end-engaging flange means 180. In this embodiment, the ceiling panel member 197 is arranged even on the region between the other end of the intermediate roof unit 42 in the lengthwise direction thereof and the end-engaging flange means 180 near the other end. According to this embodiment as described above, the ceiling panel member 197 can be arranged in the intermediate roof unit 42, and the roof unit and the ceiling can be integrally formed together offering practical advantage. Similarly, at least one ceiling panel member is arranged on the lower surface of the roof unit 40

of the one side on at least the inner regions of the end-engaging flange means 180 and of the one side-engaging flange means 190, or on the lower surface of the roof unit 44 of the other side on at least the inner regions of the end-engaging flange means 180 and of the other side-engaging flange means 192.

Referring to Figs. 53 and 54, a seal plate member is detachably mounted on the upper end between the vertical walls 160a of the channel plates 160 facing each other of the roof units 40, 42 and 44 neighboring each other. The seal plate member 200 is made of an elastic metal such as aluminum, and includes a flat plate-like sealing substrate 201 having a predetermined width, both end flanges 202 extending from both ends of the sealing substrate 201 in the direction of width into the side of one surface at right angles with the one surface, and a central flange 203 extending from the center of the sealing substrate 201 in the direction of width into the side of one surface at right angles with the one surface. The sealing substrate 201, both end flanges 202 and central flange 203 have the same thickness and extend by the same length from the one surface of the sealing substrate 201. The distance between the central flange 203 and both end flanges 202 is slightly larger than the width of the upper flanges 160b of the channel plates 160 facing each other of the roof units 40, 42 and 44 neighboring each other. The overall length of the seal plate member 200 is nearly equal to the overall length of the roof units 40, 42 and 44 in the lengthwise direction.

The channel plates 160 are fastened together by bolts 204, washers 205, annular plates 206 arranged between the vertical walls 160a and nuts 207 (mounting holes that are in alignment are arranged in a plural number in the vertical walls 160a of the channel plates 160 facing each other) in a state where the central flange 203 of the seal plate member 200 is inserted from the upper side into between the vertical walls

160a of the channel plates 160 facing each other, and the sealing substrate 201 is placed on the upper surfaces of the upper flanges 160b of the channel plates 160. Both end flanges 202 of the seal plate member 200 are folded in the directions to approach each other (in the directions indicated by arrows in Fig. 54) with the ends of the upper flanges 160b of the channel plates 160 as fulcrums. The seal plate member 200 is firmly mounted among the upper flanges 160b of the channel plates 160 facing each other of the roof units 40, 42 and 44 neighboring each other, and gaps among the roof units 40, 42 and 44 neighboring each other are easily and reliably sealed to prevent the leakage of water. The seal plate member 200 can be easily mounted on the gaps among the roof units 40, 42 and 44 neighboring each other by plugging or bending, and can be easily removed, either.

Referring to Figs. 1 and 26, as will be obvious from the above description, the roof units 40, 42 and 44 are placed on the upper ends of the frame 2 so as to cover the upper space R1 of the frame 2 from the upper side, whereby the end-engaging flange means 180 are positioned being overlapped on the inner sides and/or the outer sides of the corresponding upper side beams 20 and 24 (intermediate roof unit 42), or the end-engaging flange means 180 are positioned being overlapped on the inner sides and/or the outer sides of the corresponding upper side beams 20 and 24, and the one side-engaging flange means 190 is positioned being overlapped on the inner sides and/or on the outer sides of the corresponding upper side beam 26 (roof unit 40 of the one side), or the end-engaging flange means 180 are positioned being overlapped on the inner sides and/or the outer sides of the corresponding upper side beams 20 and 24, and the other side-engaging flange means 192 is positioned being overlapped on the inner sides and/or on the outer sides of the corresponding upper side beam 22 (roof unit 44 of the

other side). Upon being detachably fastened by bolts 196 and internally threaded members 195 (see Fig. 29), the roof units 40, 42 and 44 are mounted on the frame 2 so as to cover the upper space R1 from the upper side. As described above, the roof units 40, 42 and 44 are detachably fastened to the frame 2 easily, reliably and quickly by using bolts 196 and internally threaded members 195. The roof units 40, 42 and 44 have the end-engaging flange means 180, one side-engaging flange means 190, other side-engaging flange means 192 and roof body excluding the ceiling panel member 197, that are formed in a rectangular shape having a nearly constant thickness, and are, hence, simple in appearance and are suited for being transported and stored. Each roof body integrally incorporates braces 169 that extend horizontally, and maintains excellent quake-proof structure. Each roof body is constituted by common parts and contributes to decreasing the cost.

Referring to Fig. 1, in the above solid structure, the frame 2 is constituted by detachably fastening the corner struts 4, 6, 7 and 8, side beams 10, 12, 14 and 16, inner side beam 18, upper side beams 20, 22, 24 and 26 by using bolts and internally threaded members (inclusive of nuts). This constitution makes it possible to very easily and quickly carry out the operation for assembling the solid structure on the site and, hence, to very shorten the period for assembling and to greatly decrease the total cost. Further, the disassembling operation on the site can be very facilitated and quickened making it possible to greatly shorten the period for disassembling and removal. The coupling structure for coupling the constituent elements of the frame 2 described above is widely applicable to the frames included in a variety of solid structures, enables the operation for assembling the solid structure to be facilitated and quickened on the site,

and makes it possible to shorten the period of assembling and to greatly decrease the total cost. In a state of being fitted into the side edge space S1 to S4, the side wall units 30, 32, 34 and 36 are detachably fastened to the frame 2 by bolts and internally threaded members to further promote the above-mentioned effects. The floor units 38 are detachably fastened to the frame by bolts and internally threaded members in a state of being fallen on the floor spaces F1 and F2 to further promote the above-mentioned effects. The roof units 40, 42 and 44 are detachably fastened to the frame 2 by bolts and internally threaded members in a state of being placed on the upper ends of the frame 2 so as to cover the upper space R1 to further promote the above-mentioned effects. The corner struts 4, 6, 7 and 8, side beams 10, 12, 14 and 16, inner side beam 18, upper side beams 20, 22, 24 and 26, side wall units 30, 32, 34 and 36, floor units 38, and roof units 40, 42 and 44 are simply constituted, and the assembly thereof is also simple in constitution maintaining a sufficient strength. The above-mentioned elements are relatively light in weight and are simple in constitution, and require reduced space and cost for storage. Further, the transportation is very facilitated up to the site and the cost of transportation can be decreased.

The side wall units 30, 32, 34 and 36 and the frame 2 are coupled together by fastening bolts to the internally threaded members buried in the corresponding corner struts 4, 6, 7 and 8, side beams 10, 12, 14 and 16, and upper side beams 20, 22, 24 and 26, enabling the assembling to be accomplished easily, reliably and quickly while maintaining a required strength of the frame 2 (or rather increasing the strength). It is allowed to effect the disassembling easily, reliably and quickly, as a matter of course. According to another embodiment, the side beams 10, 12, 14 and 16 are made of metallic pipes (e.g., steel pipes) having a square shape in cross

section.

The roof units 40, 42 and 44 and the frame 2 are coupled together by fastening bolts to the internally threaded members buried in the corresponding upper side beams 20, 22, 24 and 26, enabling the assembling to be accomplished easily, reliably and quickly while maintaining a required strength of the frame 2 (or rather increasing the strength). It is allowed to effect the disassembling easily, reliably and quickly, as a matter of course.

The above-mentioned solid structure can be used for a multiplicity of purposes such as an office, a working place, a temporary house, a lodging house, a store or a structure having upper internal space that is partitioned by the floor units 38 (e.g., office, domicile, working place) and the lower part thereof being used as external space such as garage. According to the embodiment, further, the solid structure can be used as a temporary warehouse by arranging the side beams 10, 12, 14 and 16 at the lower ends of the corner struts 4, 6, 7 and 8, removing the inner side beam 18, and without arranging the floor units 38.

All of the constituent elements in the above solid structure are produced in advance in the factory, transported to the site of installation and are assembled at a low cost and within short periods of time.

Next, another embodiment of the solid structure constituted according to the present invention will be described with reference to Figs. 33 to 52. The another embodiment of the solid structure illustrated in Figs. 33 to Fig. 52 has the constitutions which are substantially the same as those of the above-mentioned embodiment, but is not provided with floor units. Besides, the constitution of the roof units is slightly different. Therefore, the constitutions which are basically in common are not described or are described only

briefly.

Referring to Figs. 33, 39, 40 and 44, another embodiment of the solid structure constituted according to the present invention includes a frame 210 substantially forming a solid space of a rectangular parallelopiped shape. The frame 210 has four corner struts 212, 214, 216 and 218. Side struts 220 and 222 are arranged between the corner struts 212 and 24, a side strut 224 is arranged between the corner strut 214 and 216, side struts 226 and 228 are arranged between the corner struts 216 and 218, and a side strut 230 is arranged between the corner struts 218 and 212.

The lower ends of the corner strut 212, side strut 220, side strut 222 and corner strut 214 are coupled by lower side beams 232 extending horizontally, and the upper ends thereof are coupled by upper side beams 234 that are horizontally extending. The lower ends of the corner strut 214, side strut 224 and corner strut 216 are coupled by lower side beams 232 extending horizontally, and the upper ends thereof are coupled by upper side beams 234 that are horizontally extending. As for the corner strut 216, side strut 226, side strut 228 and corner strut 218, the lower ends of the corner strut 216 and the side strut 226 are coupled by a lower side beam 232 extending horizontally, and the lower ends of the side strut 228 and the corner strut 218 are coupled by a lower side beam 232 extending horizontally, but the lower ends between the side strut 226 and the side strut 228 is not coupled. The upper ends of the corner strut 216, side strut 226, side strut 228 and corner strut 218 are coupled by upper side beams 234 that are horizontally extending. The lower ends of the corner strut 218, side strut 230 and corner strut 212 are coupled by lower side beams 232 extending horizontally, and the upper ends thereof are coupled by upper side beams 234 that are horizontally extending.

The upper ends between the side struts 220 and 228 and the upper ends between the side struts 222 and 226 are coupled by upper inner side beams 236 that are horizontally extending. The upper inner side beams 238 are coupling the side strut 230 to the center in the lengthwise direction of the upper inner side beam 236 facing the side strut 230, coupling together the centers in the lengthwise direction of the upper inner side beams 236, and are coupling the side strut 224 to the center in the lengthwise direction of the upper inner side beam 236 facing the side strut 224. Referring to Figs. 40 and 44, the crossing diagonal lines in the six rectangular spaces represent braces arranged on the upper ends of the frame.

The corner struts 212, 214, 216, 218 and the side struts 220, 222, 224, 226, 228 and 230 are constituted by metallic pipes having a square shape in cross section or, in this embodiment, by steel pipes having an ortho-square shape in cross section, which are common parts. Rectangular base plates are secured by welding to the lower ends of the corner struts 212, 214, 216, 218 and the side struts 220, 222, 224, 226, 228 and 230. The corner struts 212 to 218 and the side struts 220 to 230 are erected being detachably secured onto the foundation or being placed on the ground G.

The lower end beams 232 which are the common parts are constituted by H-beams having a web, an upper flange and a lower flange. The upper side beams 234 which are the common parts are constituted by metallic pipes having a square shape in cross section or, in this embodiment, by steel pipes having an ortho-square shape in cross section. The upper inner side beams 236 which are the common parts are constituted by H-beams having a web, an upper flange and a lower flange. Further, the upper inner side beams 238 which are the common parts are constituted by H-beams having a web, an upper flange and a lower flange. The constituent elements of the frame 210 are all

detachably coupled by bolts and internally threaded members. Their coupling structures will be described later.

The frame 2 forms four side edge regions like that of the above-mentioned embodiment. Two rectangular side edge spaces are formed in each of the pair of side edge regions facing each other, and three rectangular side edge spaces are formed in each of the other pair of side edge regions facing each other. A shutter 239 (see Figs. 36 and 39) is arranged in the side edge space surrounded by the side struts 226, 228 facing each other in the horizontal direction, upper side beam 234 and ground G, which is one of the total of ten side edge spaces formed by the frame 210, but no side wall unit is arranged (this side edge space is utilized as an entrance to the solid structure). Rectangular side wall units 240, 241, 242, 243, 244, 245, 246, 247 and 248 are fitted to the other nine side edge spaces, and are all detachably coupled to the frame 210 using bolts and internally threaded members. Constitutions of the side wall units 240 to 248 and coupling structures to the frame 210 will be described later.

As described above, the frame 210 includes corner struts 212 to 218, side struts 220 to 230, upper side beams 234 and lower side beams 232 coupling the upper ends thereof and the lower ends thereof and defining a rectangular peripheral edges of the frame 210 as viewed on a plane, and upper inner side beams 236 and 238. A total of six rectangular upper spaces are formed in the upper end of the frame 210 being surrounded by the corner struts 212 to 218, side struts 220 to 230, upper side beams 234, and upper inner side beams 236 and 238. A roof unit 250 of the one side, four intermediate roof units 251, 252, 253 and 254, and a roof unit 255 of the other side, are mounted so as to cover the whole upper space from the upper side, and are all detachably coupled using bolts and internally threaded members. The rectangular roof units 250 to 255 are

constituted by using common parts. A trough unit 256 of the one side of a rectangular shape is attached to the one side of the roof unit 250 of the one side, and a trough unit 257 of the other side of a rectangular shape is attached to the other side of the roof unit 255 of the other side. Constitutions of the roof units 250 to 255, and of the trough units 256 and 257, and the coupling structures to the frame 210 will be described later.

The coupling structures of the lower side beams 232 to the corner struts 212 to 218 of the frame 210 are substantially the same as the coupling structures (coupling structures by crossing a plurality of internally threaded members) illustrated in Figs. 8 to 10, and are not described here.

Described below is a coupling structure for coupling the side strut 230 to the lower side beams 232. Referring to Figs. 33 and 35, ends of the lower side beams 232 are coupled to the side walls of the side strut 230 facing each other in the horizontal direction along the side edges of the frame 210. A plurality of pairs (two pairs in this embodiment) of internally threaded members 260 extending in parallel at the same height maintaining a distance in the horizontal direction and forming internally threaded holes at both ends, are buried between the side walls of the side strut 230 maintaining a distance in the up-and-down direction in a manner that the internally threaded holes are opened in the corresponding side walls. Each of the internally threaded members 260 has substantially the same constitution as the one that is forming internally threaded holes 136 at both ends of the internally threaded member 137 illustrated, for example, in Fig. 13, and is secured to the side strut 230 by welding. A rectangular coupling plate 262 is secured to the ends of the lower side beams 232 at right angles thereto, and a plurality of mounting holes 264 are formed in the coupling plate 262 on either side

divided by the web W maintaining a distance in the up-and-down direction.

The lower side beam 232 of the one side has the coupling plate 262 that is substantially brought into contact with the one side wall of the side strut 230 in a manner that the mounting holes 264 of the coupling plate 262 are in alignment with the internally threaded holes formed in the one side wall of the side strut 230, and is detachably fastened to one side wall of the side strut 230 by bringing the bolts 266 into engagement with the internally threaded holes formed in one end of the internally threaded member 260 through the mounting holes 264. The other lower side beam 232 of the other side has the coupling plate 262 that is substantially brought into contact with the other side wall of the side strut 230 in a manner that the mounting holes 264 of the coupling plate 262 are in alignment with the internally threaded holes formed in the other side wall of the side strut 230, and is detachably fastened to other side wall of the side strut 230 by bringing the bolts 266 into engagement with the internally threaded holes formed in the other end of the internally threaded member 260 through the mounting holes 264.

Coupling structures for coupling the other side struts 220, 222 and 224 and the lower side beams 232 are substantially the same as the above-mentioned coupling structure. No lower side beam 232 exists between the side struts 226 and 228. Namely, the lower side beams 232 are coupled to the one side wall of each of the side struts 226 and 228. Therefore, internally threaded holes are formed in one end only of the internally threaded members 260 buried in the side struts 226 and 228. The lower side beams 232 have upper surfaces of substantially the same height or, in other words, are positioned on a common plane. In this embodiment, the lower side beams 232 have substantially the same shape and the same

size in cross section. In an embodiment in which an end of an inner side beam (not shown) having substantially the same constitution as the lower side beam 232 is coupled to the inner side wall of the side strut 230 facing the inner side of the solid space in the frame 210 by using the coupling structure described with reference to Fig. 35, it is allowable to use the coupling structure which is substantially the same as the coupling structure (crossing a plurality of internally threaded members) illustrated in Figs. 8 to 10. More concretely, the internally threaded holes 52 in the internally threaded members 50 in the coupling structure illustrated in Figs. 8 to 10 are formed at both ends of the internally threaded members 50. As a result, the upper surface of the inner side beam can be coupled to the side strut 230 at a position of substantially the same height as the upper surfaces of the lower side beams 232.

The coupling structures for coupling the corner struts 212 to 218 to the upper side beams 234 are substantially the same as the coupling structures illustrated in Figs. 13 and 14, and are not described here.

Next, described below are the structures for coupling the side strut 228 to the upper side beams 234 and to the upper inner side beam 236. Referring to Figs. 33 and 45, an end of the upper inner side beam 236 is coupled to the inner side wall at the upper end of the side strut 228 facing the inside of the solid space of the frame 210, and the ends of the upper side beams 234 are coupled to the side walls at the upper end of the side strut 228 that are facing in the horizontal direction along the side edges of the frame 210. The coupling structures for coupling the side strut 228 to the upper side beams 234 are substantially the same as the coupling structure illustrated in Figs. 13 and 14. In the coupling structure illustrated in Figs. 13 and 14, the upper side beams 20 and

26 are coupled to the inner side walls 46 and 47 meeting at right angles of the corner strut 4. In the coupling structure illustrated in Fig. 45, on the other hand, the upper side beams 234 are coupled to the side walls at the upper end of the side strut 228 facing in the horizontal direction along the side edges of the frame 210 making a difference from the above structure. The coupling structure using bolts, however, is substantially the same.

The coupling structure for coupling the upper inner side beam 236 to the inner side wall of the side strut 228 is substantially the same as the coupling structure illustrated in Fig. 35. In the coupling structure illustrated in Fig. 35, internally threaded holes are formed at both ends of the internally threaded member buried in the side strut 230. In the coupling structure illustrated in Fig. 45, on the other hand, the internally threaded holes may be formed at one end of the internally threaded member buried in the side strut 228. A coupling plate 267 secured to an end of the upper inner side beam 236 is so formed as to greatly extend downward from the end of the upper inner side beam 236. A nearly arcuate reinforcing plate 268a, nearly triangular reinforcing plates 268b and 268c, and a nearly rectangular reinforcing plate 268d are secured by welding between the lower end of the coupling plate 267 and the lower flange LF of the upper inner side beam 236. Due to this constitution, a sufficiently large strength is maintained by the coupling portion coupling the upper inner side beam 236 to the inner side wall of the side strut 228.

The coupling structure substantially the same as the coupling structure coupling the side strut 228 to the upper side beams 234 and to the upper inner side beam 236, can also be applied to the coupling structure for coupling the side strut 220 to the upper side beams 234 and to the upper inner side beam 236, to the coupling structure for coupling the side strut

222 to the upper side beams 234 and to the upper inner side beam 236, and to the coupling structure for coupling the side strut 226 to the upper side beams 234 and to the upper inner side beam 236.

Referring to Fig. 33, the structure for coupling the side struts 230 and 224 to the upper side beams 234 is substantially the same as the structure for coupling the side strut 228 to the upper side beams 234, and the structure for coupling the side struts 230 and 224 to the upper inner beam 238 is substantially the same as the structure for coupling the side strut 228 to the upper inner side beam 236 (however, the length of the coupling plates secured to the ends of the upper inner side beams 238 is selected to be nearly equal to the distance between the upper surface of the upper flange UF and the lower surface of the lower flange LF, and the reinforcing plates 268a to 268d are not arranged).

The structure for coupling the upper inner side beam 238 and the upper inner side beam 236 is substantially the same as the coupling structure illustrated in Figs. 11 and 12. Fig. 41 illustrates a structure for coupling the end of the upper inner beam 238 to the side of the upper inner side beam 236. The height of the upper inner side beam 238 is lower than the upper inner side beam 236 and, hence, the coupling plate 269 is lengthened by an amount that is insufficient, and is hanging from the lower surface of the upper inner side beam 238.

As described earlier with reference to Fig. 33, side wall units 240 to 248 are fitted to nine side edge spaces of the frame 210, and are all detachably fastened to the frame 210 by bolts and internally threaded members. The basic constitution of the side wall units 240 to 248 is substantially the same as that of the side wall unit 30 described earlier except that the hollow mounting members 270 that will be described later are made of cast iron that can be welded. In

the above embodiment, further, the side wall units 30 to 36 are mounted in a number of one in each of the rectangular side edge spaces. In the embodiment illustrated in Fig. 33, on the other hand, two side wall units are fitted neighboring each other in each rectangular side edge space, and are mounted on the frame 210 being coupled to each other. Concretely speaking as illustrated in Fig. 33, the side wall units 240, 241 and 242 are, respectively, constituted by side wall units 240a and 240b, side wall units 241a and 241b, and side wall units 242a and 242b, that are coupled together. Other side wall units, too, are all constituted by two side wall units, respectively (for example, the side wall unit 247 is constituted by side wall units 247a and 247b that are coupled together).

Referring to Figs. 33, 35 and 43, the side wall unit 247a of the side wall unit 247 has hollow mounting members 270 arranged at the corners and side edges like the side wall unit 30. The hollow mounting member 270 is made of cast iron that can be welded as a unitary structure, and includes four side walls having a predetermined thickness and a width in the axial direction or, in this embodiment, includes four side walls 271 having the same thickness and the same width in the axial direction. Braces 272 are formed at four corners of the hollow mounting member 270 stretching between the two side walls 271 meeting at right angles. Each brace 272 has a predetermined thickness and a width in the axial direction which is same as that of the two side walls 271, and is integrally arranged so as to form a right-angled triangle relative to the two side walls 271 as viewing the hollow mounting member 270 in the axial direction. Mounting holes 273 are formed in the side wall 271 of the hollow mounting member 270 depending upon the layout of being arranged at the corner or on the side edge in substantially the same manner as that of the side wall unit 30. Despite of its simple structure, the thus constituted

hollow mounting member 270 maintains a sufficiently large strength against the load from the upper direction and against the load from the transverse direction.

Two side wall units 247a and 247b are fitted to the side edge space formed being surrounded by the corner strut 218, side strut 230, upper side beam 234 and lower side beam 232, the two side wall units 247a and 247b neighboring each other. In the side wall unit 247a and 247b neighboring each other, the side walls 271 of the hollow mounting members 270 constituting portions of the opposing side walls are positioned so as to be opposed to each other, and the mounting holes 273 are positioned to be in alignment with each other. The side wall units 247a and 247b neighboring each other are detachably fastened to each other by inserting bolts 274 in the mounting holes 273 in alignment of the hollow mounting members 270 facing each other and engaging nuts 275 therewith. Suitable annular plates are interposed between the hollow mounting members 270 facing each other. Internally threaded members 277 are buried, in substantially the same manner as described in the above embodiment, in the corner strut 218, side strut 230, upper side beam 234 and lower side beam 232 defining the side edge space to which the side wall unit 247 is to be fitted, and the side wall unit 247 is detachably fastened thereto by bolts 278. Other side wall units 240 to 246 and 248, too, are constituted in substantially the same manner as the one described above, and the two units constituting each of the units are coupled together and are coupled to the frame 210 by using the same coupling mechanism.

Fig. 34 illustrates a state where boards and windows are mounted on the side wall units 247 and 248 illustrated in Fig. 35. Fig. 36 illustrates a state where the side wall units 245 and 246 are mounted on the frame 210, the side wall units 245 and 246 mounting the boards and windows. This side surface

constitutes an entrance/exit equipped with a shutter 239. Fig. 37 illustrates a state of mounting the frame but removing the shutter 239, boards and windows from the side wall units 245 and 246 illustrated in Fig. 36. Fig 38 illustrates a state where the side wall units 240, 241 and 242 illustrated in Fig. 33 are mounted on the frame 210, the side wall unit 240 having boards and windows mounted thereon, the side wall unit 241 having boards mounted thereon, and the side wall unit 242 being in the state of the frame.

As described earlier, further, one roof unit 250 of the one side, four intermediate roof units 251, 22, 253 and 254, and one roof unit 255 of the other side are mounted on the upper ends of the frame 210 so as to cover the whole upper space from the upper side (see Figs. 38, 42 and 44). These roof units 250 to 255 are constituted by using common parts. Therefore, the constitution of the intermediate roof unit 252 and the coupling structure thereof will be described representatively. Referring to Figs. 44, 45 to 49, the intermediate roof unit 252 includes a plurality of channel plates 280 that are arranged in a rectangular shape to define the peripheral edges and having open ends facing inward. The channel plate 280 is constituted by a vertical wall 280a, and an upper flange 280b and a lower flange 280c folded inward at right angles from the upper end and the lower end of the vertical wall 280a. Each channel plate 280 is constituted by a suitable metal plate or, in this embodiment, by a steel plate.

Between the vertical walls 280a of the channel plates 280 of the intermediate roof unit 252 facing each other in the direction of width, there are arranged a plurality of transverse beams 282 maintaining a distance in the lengthwise direction from a position close to one end (position close the left end in Figs. 45, 46 and 48) in the lengthwise direction of the intermediate roof unit 252 and from a position close

to the other end (position close the right end in Figs. 45, 46 and 48) toward the central position in the lengthwise direction of the intermediate roof unit 252 in a manner that the height thereof gradually increases. The horizontally extending transverse beams 282 are constituted by metallic pipes or, in this embodiment, by steel pipes having a square shape in cross section, and are secured at their both ends by welding to the vertical walls 280a of the corresponding channel plates 280. The upper surfaces of the transverse beams 282 are substantially positioned on the two inclined planes inclining downward toward both ends from the center in the lengthwise direction.

At both ends of the intermediate roof unit 252 in the lengthwise direction, the channel plates 280 defining the three peripheral edges have a height larger than the height of the channel plates 280 defining the peripheral edges of other regions excluding both ends in the lengthwise direction, and the upper surfaces (upper surfaces of the upper flanges 280b of the channel plates 280) at both ends of the intermediate roof unit 252 in the lengthwise direction are positioned substantially in flush with the upper surfaces of other regions of the intermediate roof unit 252. Due to this constitution, the bottoms (lower flanges 280c of the channel plates 280) at both ends of the intermediate roof unit 252 in the lengthwise direction are positioned to be lower than the other regions of the intermediate roof unit 252. Trough members 284 extending in the direction of width of the intermediate roof unit 252 are arranged at one end and at the other end of the intermediate roof unit 252 in the lengthwise direction thereof. The trough member 284 is constituted by a metal plate or, in this embodiment, a steel plate of the shape of a channel which is opened upward, and has flanges at the upper ends of both side walls in the direction of width that are folded

horizontally in a direction to approach each other. The trough member 284 is arranged between the vertical walls 280a facing each other in the direction of width of the channel plates 280 arranged at one end of the intermediate roof unit 252 in the lengthwise direction, and are secured by welding. A drain port 285 is formed in the bottom of the trough member 284. The bottom of the trough member 284 is arranged at nearly the same height as the bottoms of both ends of the intermediate roof unit 252 in the lengthwise direction.

On the transverse beams 282, there is attached at least one roof plate 286 of the one side so as to extend being inclined downward from the center of the intermediate roof unit 252 to the one end thereof in the lengthwise direction. On the transverse beams 282, there is further attached at least one roof plate 287 of the other side so as to extend being inclined downward from the center of the intermediate roof unit 252 to the other end thereof in the lengthwise direction. The lower end in the lengthwise direction of the one roof plate 286 having the smallest height and the lower end in the lengthwise direction of the other roof plate 287 having the smallest height, are positioned over their corresponding trough members 284. End-engaging flange means 290 are hanging down from the lower surfaces at both ends of the intermediate roof unit 280 in the lengthwise direction thereof extending substantially the whole region thereof in the direction of width. The end-engaging flange means 290 have substantially the same constitution as the end-engaging flange means 180 of the embodiment described earlier (in this embodiment, the end-engaging flange means 290 is constituted by a pair of end-engaging flanges 291 and 292 formed integrally together).

Internally threaded members forming internally threaded holes at one end thereof are buried in the upper side beams 234 defining a pair of side edges facing each other (a pair

of side edges facing each other in the up-and-down direction in Fig. 44) of the frame 210 at portions coupled to the roof unit 250 of the one side, to the intermediate roof units 251 to 254 and to the roof unit 255 of the other side, the internally threaded members extending in a horizontal direction to face each other in a manner that the internally threaded holes are opened in the inner side walls of the corresponding upper side beams 234 facing the upper space. This constitution, too, is substantially the same as that of the above-mentioned embodiment, and is not described here again.

The roof unit 250 of the one side, the intermediate roof units 251 to 254 and the roof unit 255 of the other side are placed at their both ends on the upper side beams 234 facing each other, and have pairs of end-engaging flanges 291 and 292 of the end-engaging flange means 290 overlapped on the inner sides and the outer sides of the corresponding upper side beams 234, and are detachably fastened from the inner sides by bolts and internally threaded members.

Referring to Figs. 33, 44, 50, 51 and 52, one side edge (left side edge in Fig. 44) in the direction of width of the roof unit 250 of the one side positioned on one side (left side in Fig. 44) in the direction in agreement with the direction of width of the roof units 250 to 255 in the upper space, is positioned midway in the direction of width (midway in the right-and-left direction in Figs. 44 and 51) of at least one (two in this embodiment) upper side beam 234 defining one side edge (left side edge in Fig. 44) of the other pair of side edges (pair of side edges facing each other in the right-and-left direction in Fig. 44) facing each other of the frame 210, and midway in the direction of width of the struts positioned on the extensions of the upper side beams 234 (in a state where the roof unit 250 of the one side is placed at predetermined positions on the upper ends of the frame 210). The other side

(right side in Fig. 44) of the trough unit 256 of the one side of a rectangular shape on a plane is detachably attached to the one side of the roof unit 250 of the one side in the direction of width.

The trough unit 256 of the one side includes a trough member 296 and a channel plate 294 arranged in a rectangular shape having a length nearly equal to the roof unit 250 of the one side in the lengthwise direction and having an open end facing inward. The channel plate 294 is constituted by a vertical wall 294a, and an upper flange 294b and a lower flange 294c folded inward at right angles from the upper end and the lower end of the vertical wall 294a. The channel plate 294 is constituted by a suitable metal plate or, in this embodiment, by a steel plate. The trough member 296 having a channel shape in cross section and is opened upward, is extending between the vertical walls 294a of the channel plates 294 facing each other in the lengthwise direction of the trough unit 256 of the one side, is secured thereto by welding, and has a drain port 297 formed in the bottom thereof. Just on the trough member 296 between the vertical walls 294a facing each other in the direction of width of the trough unit 256 of the one side, a plurality of transverse beams 298 are arranged maintaining a distance in the lengthwise direction of the trough unit 256 of the one side and are secured at their both ends to the vertical walls 294a by welding. The height of the channel plate 294 defining the other side (right side in Fig. 51) in the direction of width of the trough unit 256 of the one side is selected to be substantially the same as the height of the channel plate 280 defining the one side (left side in Fig. 51) in the direction of width of the roof unit 250 of the one side. A mounting member 300 having a mounting piece 302 is secured to the channel 294 defining the other side in the direction of width of the trough unit 256 of the one side, the

mounting piece 302 hanging down from the lower surface of the channel plate 294. Channel-like reinforcing members 299 opened downward are arranged just under the transverse beams 298 between the trough member 296 and the mounting piece 302, and are secured by welding to the vertical walls 294a facing each other in the lengthwise direction of the trough unit 256 of the one side, to the neighboring trough member 296 and to the mounting piece 302. The trough unit 256 of the one side has the outer surface of the vertical wall 294a of the channel plate 294 defining the other side in the direction of width of the trough unit 256 of the one side that is overlapped on the outer surface of the vertical wall 280a of the channel plate 280 defining the one side in the direction of width of the roof unit 250 of the one side, and is detachably fastened by using bolts 304 and nuts 306.

In a state where the roof unit 250 of the one side is placed on the upper ends of the frame 210 at a predetermined position, the bottom surface of the channel plate 294 (bottom surface of the lower flange 294c) defining the other side in the direction of width of the trough unit 256 of the one side is placed on the outer regions in the direction of with of the upper surfaces of the upper side beams 234, corner struts 212, 218 and the side strut 230, and the mounting piece 302 is overlapped on the outer side walls of the upper side beams, corner struts 212, 218 and side strut 230, enabling the roof unit 250 of the one side to be detachably fastened to the upper side beams 234 by using bolts 308 and internally threaded members 310. The internally threaded members 310 are buried in the upper side beams 234 at the coupling portions in the same manner as in the embodiment described above. The trough unit 257 of the other side has substantially the same shape and the same size as the trough unit 256 of the one side (the right and the left are reversed in Figs. 44 and 51) and is

coupled to the other side of the roof unit 255 of the other side in substantially the same manner as the one described above.

As will be easily comprehended from the foregoing description, the another embodiment of the solid structure of the invention described with reference to Figs. 33 to 52 has the basic constitutions possessed by the embodiment described earlier with reference to Figs. 1 to 32, and is capable of achieving substantially the same action and effect as those of the embodiment described earlier. The solid structure according to the another embodiment of the invention described with reference to Figs. 33 to 52 can be applied to, for example, warehouses and factories.

Fig. 55 schematically illustrates the constitution of a further embodiment of the solid structure constituted according to the present invention. The solid structure of the embodiment illustrated in Fig. 55 has a frame 400 which forms a solid space of substantially a rectangular parallelopiped shape. The frame 400 includes a plurality of corner struts 402, 404, --- arranged in a rectangular shape as viewed on a plane, side struts 410, 412, ---, side beams 420, 422, 424, 426, ---, inner beams 430, ---, upper side beams 440, 442, 444, ---, floor units 450, ---, side wall units 460, 462, 464, ---, and roof units 470, 472, ---. Constitutions of the corner struts 402, 404, ---, side struts 410, 412, ---, side beams 420, 422, 424, 426, ---, inner beams 430, ---, and upper side beams 440, 442, 444 constituting the frame 400 and their coupling structures are substantially the same as those described in the above embodiments. Constitutions of the floor units 450, --- and their coupling structures to the frame 400 are substantially the same as those for the floor units 38 of the embodiments described above. Further, constitutions of the side wall units 460, 462, 464, --- and their coupling

structures to the frame 400 are substantially the same as those of the side wall units 30 to 34 and side wall units 242 to 248 of the embodiments described above. Constitutions of the roof units 470, 472, --- and the coupling structures to the frame 400 are substantially the same as those for the roof units 250 to 255 of the embodiments described above. In Fig. 55, major portions substantially the same as those of the above-mentioned embodiments are denoted by the same reference numerals. Therefore, this embodiment, too, has substantially the same basic constitutions as those of the embodiment described above, and achieves the actions and effects substantially the same as those of the embodiments described above.

In the above embodiments, the frames 2, 210 and 400 are constituted by steel members, which, however, may be partly or entirely constituted by a reinforced concrete. For example, when the corner strut 4 is constituted by using a reinforced concrete having a square shape in cross section, a pair of first internally threaded members 50 and a pair of second internally threaded members 56 are buried in the concrete in a manner that the internally threaded holes 52 and 55 are opened in the outer surfaces of the one side wall 46 and of the other side wall 47. Further, when the upper side beams 20 and 26 are to be coupled to the corner strut 4 which is constituted by the reinforced concrete having a square shape in cross section by using coupling structures illustrated in Figs. 13 and 14, at least the upper end of the corner strut 4 must be constituted by a metallic pipe having a square shape in cross section. The metallic square pipe constituting the upper end is formed integrally with the reinforced concrete.

When the corner struts and/or the side struts are formed by using the reinforced concrete, the present invention can be applied despite the struts have a polygonal shape in cross

section (e.g., octagonal shape, dodecagonal shape, etc.). The corner strut formed in a polygonal shape in cross section must have a pair of side walls which meet at right angles when the outer surfaces thereof are extended (in this specification, the above side walls are expressed as "inner side walls meeting each other at right angles and facing in the horizontal direction along the side edges of the frame meeting each other at right angles"). This is because the side beams are coupled to the above pair of side walls (extensions of the side beams meet each other at right angles). The side strut formed in a polygonal shape in cross section must have a pair of side walls which face to each other in parallel when the outer surfaces thereof are extended (in this specification, the above side walls are expressed as "side walls facing each other in the horizontal direction along the side edges of the frame"). This is because the side beams are coupled to the above pair of side walls (extensions of the side beams come in contact with each other at the ends). Further, corner square struts and/or the side struts having a square shape in cross section include those sectional shapes of which the corners of the square are chamfered linearly or in a curved manner irrespective of whether they are made of the reinforced concrete. The square shape in cross section includes the above shapes.